1984 Migration Patterns, Abundance, Age, Size and Sex Composition of Hobiton Lake Adult Sockeye Salmon *(Oncorhynchus nerka)*

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1984 MIGRATION PATTERNS, ABUNDANCE, AGE, SIZE AND SEX COMPOSITION OF HOBITON LAKE ADULT SOCKEYE SALMON (*Oncorhynchus nerka*)

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ABSTRACT

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The adult sockeye run to Hobiton Lake in 1984 was monitored from April 10 to August 17. The first adults passed the counting fence site on April 19. The majority (>90%) of adult fish returned between May 30 and July 9. Approximately 50% of the 1984 run returned by June 20. The total run to July 14 was estimated to be 12,383 fish, of which 778 were caught by the native food fishery and 11,517 entered the lake to spawn. Hydroacoustic surveys to estimate sockeye escapements were conducted on 10 occasions during the 1984 run and once each during the 1982 and 1983 runs. Comparisons of these hydroacoustic estimates of escapement with independent fence counts of cumulative escapement indicated that both the precision and accuracy of hydroacoustic escapement estimates was high. Errors in acoustic estimates relative to fence counts of adult sockeye ranged from as little as 1.7% to as much as 66%. Migration up the 1.3 km stretch of river between Nitinat and Hobiton lakes was mainly nocturnal, with 60% of all sockeye in the escapement moving between 2200 and 0500 hr. Five age types (1.1, 1.2, 1.3, 2.2 and 2.3) contributed to the run, but 1.2's and 1.3's predominated (78.5 and 15.7% respectively). Females were slightly more numerous than males (50.9 to 49.1%).

RESUME

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Entre le 10 avril et le 17 août 1984, on a surveillé la remonte de saumons rouges adultes vers le lac Hobiton. Le 19 avril, les premiers adultes ont franchi l'endroit où se trouvait le barrage de dénombrement. La majorité (>90%) des individus adultes sont revenus entre le 30 mai et le 9 juillet. Environ 50% des poissons qui sont remontés en 1984 étaient de retour avant le 20 juin. On a évalué la remonte jusqu'au 14 juillet à 12,383 poissons; de ce nombre, 778 ont été capturés dans le cadre de la pêche de subsistance des autochtones et 11,517 se sont rendus au lac pour frayer. A dix reprises au cours de la remonte de 1984 et une fois lors de la remonte de 1982 et de celle de 1983, on a effectué des levés hydroacoustiques afin d'évaluer le nombre de saumons rouges qui remontent. Les comparaisons qui ont été faites entre ces évaluations et les dénombrements indépendants des saumons revenant frayer effectués au barrage ont montré que les évaluations hydroacoustiques de la remonte étaient très précises. Le taux d'erreur dans les estimations hydroacoustiques par rapport aux dénombrements de saumons rouges adultes a varié d'aussi peu que 1.7% à autant que 66%. La migration en amont sur une distance de 1.3 km entre les lacs Nitinat et Hobiton s'est effectuée surtout de nuit, 60% des saumons rouges faisant parti de la remonte se déplaçant entre 22 h et 5 h. Des individus appartenant à cinq catégories d'âge (1.1, 1.2, 1.3, 2.2 et 2.3) ont participé à la remonte, mais ceux des catégories 1.2 et 1.3 étaient les plus nombreux (78.5 et 15.7% respectivement). Les femelles étaient un peu plus nombreuses que les mâles (50.9 comparativement à 49.1%).

INTRODUCTION

Between the years 1969 and 1975, investigators with the Fisheries Research Board of Canada conducted an experimental study at Great Central Lake, British Columbia to test the hypothesis that increasing the supply of inorganic nutrients in an ultraoligotrophic lake would increase production at succeeding trophic levels and would consequently serve as a useful technique to enhance the productivity of a stock of sockeye salmon. LeBrasseur et al. (1978) reported that during fertilized years mean summer primary production increased fivefold, zooplankton standing stock increased 9 times, the percentage survival from estimated potential egg deposition to juvenile sockeye increased 2.6 times, while mean stock size of adult sockeye increased from < 50,000 to > 360,000. Given the apparent 7-fold increase in Great Central Lake adult sockeye returns compared to pretreatment "historic" levels LeBrasseur et al. (1979) concluded that lake fertilization could serve as a highly cost effective technique to enhance sockeye salmon. Thus, when the Salmonid Enhancement Program (SEP) was launched in 1977 as a joint effort of the Federal and Province of British Columbia Governments, an expanded Lake Enrichment Program (LEP) was initiated as an experimental technique for the enhancement of sockeye salmon in a variety of B.C. coastal lakes. The Fisheries Research Branch (FRB) serves as the source of scientific and technical expertise with funding provided by SEP.

The primary objective of our program is to utilize lake fertilization wherever possible as a cost effective technique to maximize the production of sockeye salmon on the B.C. coast. Consequently, we conduct research in support of this long-term goal to determine when, where, how often, how well and by what biological mechanisms lake enrichment works as a technique to enhance the production of natural stocks of sockeye salmon (Stockner and Hyatt 1984).

The Fish Ecology Unit of LEP has been grappling with three general assessment issues since 1977. These are:

1. Does lake fertilization generally influence the size attained by juvenile sockeye such that smolts routinely leave at a larger size from treated as opposed to untreated coastal lakes?

2. Will larger sockeye smolts experience higher marine survivals or exhibit changes in age-at-return such that the harvestable biomass of adult sockeye available to the fishery is increased enough to more than compensate for the costs of lake treatment?

3. Does lake fertilization influence the within-lake survival of juvenile sockeye such that more smolts are produced per spawner in treated years as opposed to untreated years?

Studies are underway in a variety of coastal lakes to resolve these issues and substantial progress has been made. For example, Hyatt and Stockner (1985) have reported on the demonstration of a clear link between

enhanced production at lower trophic levels and increased size of sockeye smolts migrating from treated B.C. coastal lakes. These authors also marshall arguments in support of predictions by SEP that such changes should result in significant gains in adult sockeye returns.

Studies to contribute to the resolution of the questions listed above have been underway at Hobiton Lake since early in 1977, the lake's first year of treatment (Stephens and Stockner 1983; Manzer et al. 1984). However by 1980 it was recognized that various assessment procedures adopted previously would require increased effort and further standardization at a limited number of lakes to generate data of relatively constant precision and known accuracy on brood-year variations in smolt size, smolt abundance and adult returns. It was clear that failure to do this would prevent us from reliably assessing the impact of treatment-induced growth or size variations on within-lake survival rates, marine survival rates, age-at-return or yield of adult sockeye for any B.C. outer coast sockeye stocks. Consequently, Hobiton Lake was selected (along with Great Central, Sproat, Henderson, Long and Muriel) as a key study lake. Accordingly at Hobiton Lake we now complete multiple estimates throughout the year of juvenile sockeye growth, population size and body size at seaward migration. The entire smolt population is counted out through weirs at the lake outlet and returning adults have been enumerated and sampled at a counting fence since 1980. We have now accumulated the minimum data set on biological performance of this stock under treated conditions. Our intent is to terminate lake treatment at Hobiton during the interval 1984-86 and to continue rigorous assessment of juvenile sockeye growth and survival as well as adult returns to yield untreated "control" data on biological performance of the stock until the 1990 brood-year returns are completed.

The present report is the second in a series (e.g. see Manzer et al. 1984) written for the purpose of providing interim analyses and interpretations of the Hobiton studies as they proceed to completion. This report deals with information on stock size (escapement plus Indian Food Fishery catch), migration patterns and biological characteristics of the adult sockeye run to Hobiton Lake in 1984. We also determined the precision and accuracy of escapement estimates based on the application of hydroacoustic surveys through comparisons to independent estimates of escapement obtained at a counting fence at the lake outlet.

DESCRIPTION OF THE STOCK

Hobiton Lake produces virtually all the sockeye salmon (Oncorhynchus nerka) in the Nitinat Lake watershed. The stock supported a small commercial fishery during 1927-1957 (Kasmer, unpublished report made available by Dept. of Fisheries and Oceans, Port Alberni, B.C.) and a native food net fishery which has been carried out annually, mainly in areas adjacent to the mouth of Hobiton River. Published annual catch and escapement data for the period 1951-1977 indicate that Hobiton sockeye were most abundant during the early 1950's when total runs were estimated to be between 30-50,000 sockeye

(Fedorenko et al. 1979). By the mid-50's abundance levels declined drastically and the commercial fishery was terminated in 1958. The native food fishery has continued annually without interruption. During the 1970's the total runs were estimated by Department of Fisheries personnel to be between 2-10 thousand sockeye. Recent analyses of available information on native catches and sockeye escapements to Hobiton Lake suggest that these estimates probably are conservative (Hyatt, unpublished data). Nevertheless, it is obvious the stock is relatively small.

Virtually all Hobiton Lake sockeye spend one complete year in the lake and return as adults after 1, 2 or 3 winters in the ocean. Returns in past years have been predominantly composed of 1.2 and 1.3 sockeye. Adult sockeye are generally noticed to appear in small numbers off the mouth of the Hobiton River during early April and by comparison with many sockeye runs in southern B.C. the Hobiton run is early. In association with this early return timing, Hobiton fish tend to be smaller for a given age than many other south coast stocks, and Manzer et al. (1984) suggest that egg production per unit weight by Hobiton females of a given age is low compared to other stocks.

Because lake fertilization was initiated at Hobiton in 1977, adults returning since the summer of 1980 have primarily been the progeny of treated brood years. This feature will persist until the fall of 1988 when returning adults will once again be primarily the progeny of untreated brood years.

STUDY AREA

Hobiton Lake is located on the southwest coast of Vancouver Island. It is 4 sq km in area with a mean depth of 36 m (Shortreed and Stockner 1981). The Hobiton Lake system is used extensively by spawning chum (*Oncorhynchus keta*), chinook (*O. tschawytscha*), coho (*O. kisutch*) and sockeye (*O. nerka*) salmon (Fedorenko et al. 1979). The Hobiton River originates at Hobiton Lake and flows in a northeasterly direction for approximately 1.5 km where it joins Nitinat Lake (Fig. 1).

Hobiton River is influenced by high annual rainfall (exceeding 200 cm), which causes extreme variability in both water level and flow. Tidal fluctuations in Nitinat Lake also affect the water level of the river for a distance of 100 m upstream of the mouth.

METHODS

INDIAN FOOD FISHERY

The Indian Food Fishery (IFF) for Hobiton Lake sockeye is managed by the Nitinat Band Council under the jurisdiction of a fishing by-law granted by the Department of Fisheries and Oceans and the Department of Indian and Northern Affairs, Ottawa, in 1982. Participation in the fishery is restricted to Nitinat Band members on a permit system and regulations are enforced by a native Conservation Officer appointed by the Band Council.

The IFF total catch for 1984 was assessed at two separate areas in Nitinat Lake: the historical fishing grounds at the mouth of the Hobiton River and the area locally called Mud Flats located inside Nitinat Narrows (Fig. 1).

The 1984 Indian Food Fishery catch statistics were obtained by:

1. interviewing individual fishermen.

2. on-site observations made by field personnel.

3. personal communications with the native Conservation Officer.

4. review of native fishing permits.

On-site monitoring of the fishery at the rivermouth was conducted on a daily basis with observations made in the morning and evening. The statistics obtained on the food-fish catch are considered to be highly reliable since our field crew made catch observations on a daily basis and maintained a good reporting relationship with native fishermen and the Band Conservation Officer.

ESTIMATION OF ESCAPEMENTS

Escapement at the Hobiton Fence:

Sockeye migrating into Hobiton Lake have been difficult to enumerate by any means other than the use of a counting fence in the Hobiton River. A fence site was established approximately 0.5 km from the Hobiton Lake outlet to conduct both sockeye smolt and adult enumeration work during 1983 and the same site was occupied in 1984 (Fig. 1). Between 1980 and 1982 an alternate downstream fence site 0.5 km away from the rivermouth at Nitinat Lake was used for adult counting only. The present study site is 41 m wide and the river bottom consists of clay overlaid by compact gravel 25.4 cm in depth. The southwest bank is bedrock and sufficiently high to contain flood levels. The northeast bank consists of clay and required reinforcing with a log bulkhead and sandbags.

Preparation of the Study Site for Fence Installation 1983, 1984:

The northeast bank of the river had to be reinforced with a log bulkhead. This bulkhead (2.0 m wide x 2.4 m long) was set into the bank, and the interior of it was then filled with sandbags. The bulkhead added stability to the clay bank and reduced erosion of the bank, at the point where the fence was located. The bulkhead was built by constructing 2.0 x 2.4 m log layers which were covered with chicken wire and anchored to the river bottom by filling the interior with sandbags. This procedure was repeated until the bulkhead was 1.5 m high. A wall of sandbags was placed in front of the cribbing to deflect water away from the bank, further reducing the possibility of scouring around the northeast end of the fence.

In preparation for installation of the fence a platform floor, 2.4 m wide and 4.9 m long, was installed on the river bottom on the northeast side of the river. The purpose of this floor was to level the riverbed and thus reduce loss of freeboard on this section of the completed weir.

Description of the Fence:

The superstructure, excluding the width of the bulkhead, was 40.0 m wide and 1.2 m high. It consisted of a series of 37 vexar screens (0.6 cm mesh) measuring 1.0 m x 1.8 m, mounted on two (5.0 cm x 15 cm x 3 m) stringers supported by A-frames set 1.5 m apart. The screens were inclined downstream at an angle of 45 degrees from the perpendicular.

The vexar screens were made of two layers of 2.5 cm x 10.2 cm boards, with the vexar sandwiched between the two layers. The screens were assembled within a frame made of 5.0 x 10.2 cm boards.

A total of 27 A-frames were anchored to the river bottom with sandbags. The first five A-frames were nailed to the floor while the remaining A-frames were anchored to the streambed at their bases with 1.2 m pieces of 1.3 cm rebar. A-frames were held rigid in an upright position by two stringers bolted to the front or upstream member and extending the length of the fence.

When all the screens were in place a 1.0 m piece of vexar was stapled to the bottom of the screen and the loose end anchored to the river bottom with sandbags (Fig. 2a); this prevented adult sockeye from escaping through any spaces between the bottom of the screens and the river bottom.

The A-frames were designed so that once the fence was in position a catwalk could be added to the top of the fence (Fig. 2b). Six strands of wire were strung along the face of the fence and catwalk which were connected to a Baker electric fencer and a 12 volt battery to produce an electrified barrier. It was hoped this would discourage black bears from approaching and damaging the fence during attempts by bears to retrieve adult fish which occasionally became wedged under the fence panels. After installation the damage caused by bears ended.

A photograph of the fence is presented in Figure 2.

Installation of the Hobiton River fence started April 5 and was completed April 10. On May 20 the midsection (approx. 8.2 m) of the fence collapsed during a freshet. This section was replaced on May 23 and remained intact until its removal on July 14. During a freshet on June 29, 8 screens were removed and replaced with dowels spaced at 2.5 cm intervals to help relieve pressure due to high water on the fence.

Machine Counts of Adult Sockeye at the Fence:

Sockeye returning to the Hobiton Lake system were enumerated by an electronic fish counter installed in the counting fence and maintained from May 25 to July 14. The multiple tunnel counter (model 289) was manufactured by Pulsar Electronics Ltd., Vancouver, B.C. Operation and application of the Pulsar fish counter has been described by Manzer et al. (1984).

Sockeye were counted at the Hobiton River fence as they moved through one of eight counting tunnels (7.6 cm x 15 cm [inside measurements] x 61 cm). Two banks of tunnels were set into the northeast side of the fence. Each tunnel bank consisted of four counting tunnels and a control reference tunnel arranged horizontally.

On the northeast side of the fence a lead (12 m long x 1.0 m high) made up of A-frames and vexar screens, was placed at a 45 degree angle downstream of the superstructure. The lead directed migrating sockeye to the tunnel banks and reduced the sockeye search area from 40 m to 9 m.

White flashboards were secured to the river bottom at tunnel exits to facilitate visual counting of sockeye as they passed upstream through the tunnels.

Visual Counts for Machine Calibration:

Accuracy of upstream hourly machine counts was determined by simultaneously conducting visual counts of sockeye as they left the counting tunnels. Hand tallies were used to accumulate visual totals which were recorded on the hour. Most checks were made during the early morning hours (0500-0800) or the late evening hours (2200-0100). A total of 87 checks were made over a 45 day period from May 26 to July 10 (Appendix 1). Twelve (12) counts conducted over less than one hour were adjusted to one hour. Seven of the machine calibration counts were rejected because of either counter malfunction during the calibration period or suspected observer error (Appendix 1).

Machine error was determined by linear regression analysis of visual and machine count data. Individual hourly machine counts were adjusted for error and summed to give corrected daily totals (Table 1).

Sockeye migrating to Hobiton Lake before May 25 were enumerated visually while conducting separate studies on smolt emigration (author's unpublished data).

Any fish observed moving past the fence without passing through the counter tunnels were categorized as 'bypass'. There are four bypass categories:

1. sockeye that were enumerated visually from April 10 to May 25, 1984 (prior to electronic counter installation),

2. sockeye that bypassed the counter tunnels;

3. sockeye that were caught in the fence and released upstream of the fence; and

4. sockeye that were sampled on the downstream side of the fence and released on the upstream side.

Hydroacoustic Estimates of Escapement:

Maintenance of an electronic fish counter and fence on the Hobiton River has permitted us to obtain accurate estimates of sockeye escapement to the lake since 1980. However, total reliance on the fence and electronic counter for escapement estimates has two major drawbacks. First, operation and maintenance of the installation is labour-intensive and expensive. Second, fence washouts or fish migration late in the season, after the fence has been removed, may result in underestimation of annual escapement. Consequently, we conducted trials in 1984 to compare a series of escapement estimates based on the application of hydroacoustic surveys to independent estimates of cummulative escapement obtained at the Hobiton fence immediately prior to each hydroacoustic survey. Single escapement estimates from hydroacoustic surveys in 1982 and 1983 are also reported here.

In addition to the availability of cumulative fence counts of adult sockeye, Hobiton Lake offered a number of advantages for conducting hydroacoustic surveys of escapement. The lake is small (approx. 6.8 km x 0.8 km), thus assuring the possibility of good coverage with hydroacoustic instruments and the likelihood of rapid dispersal of adult fish throughout the lake after passage of the counting fence. Adult sockeye enter and remain well dispersed throughout the lake for an interval of 3-5 months before moving to nearshore beaches to spawn. After entry into the lake there is little, if any, movement by adult sockeye out of the lake into tributaries where spawning is precluded by steep gradients, shallow water and an absence of suitable substrates. Repeated acoustic surveys conducted prior to entry of adult sockeye indicate that the resident population of fish of a size which might be confused with adult sockeye as acoustic targets is negligible. The relatively low abundance of fish other than sockeye is further supported by the low incidence of detection of adults of fish species other than sockeye at counting weirs that have been manned continuously from mid-March to early July over the past two years (Manzer et al. 1984). Finally, annual escapements

returning to Hobiton Lake over the past 10 years have ranged from less than 5000 to greater than 45,000 adults, thus permitting a fairly wide range of population size against which acoustic estimates might be compared.

Echosounders have been routinely used by the Fish Ecology Unit of the Lake Enrichment Program to conduct annual census of populations of juvenile sockeye salmon since 1977 in 6-22 B.C. coastal lakes. Our acoustic instrumentation is simple and designed to be deployed from highly portable inflatable boats for use in remote field sites. General details regarding hardware specifications, survey design, gear deployment procedures and echogram processing are discussed elsewhere (Hyatt et al. 1984; Hyatt and Stockner 1985). Features of equipment and survey design specific to adult sockeye census are as follows. Preliminary observations indicated that during the dark hours of the night adult sockeye were generally well dispersed; however, during daylight hours congregation into numerous small schools could take place. Since the former distribution is more amenable to successful acoustic surveys based on echo counting, our surveys with but one exception (June 12, 1984) were conducted at night by completing 10-11 cross-lake transects per survey (Fig. 3).

Adult sockeye census activities conducted on Hobiton Lake by us between 1982 and 1984 relied on a 70 kHz, Simrad EYM scientific sounder with 75 watts of power output. The EYM is an uncalibrated sounder, equipped with a time varied gain (TVG) circuit which controls for spreading and attennuation losses of the acoustic signal with distance from the transducer. Gain controls on the sounder, which affect signal amplification and therefore the strength of acoustic signal that may be detected, were set at a level (normally gain 10) which permitted the detection of targets ranging in size from 3-7 cm juvenile sockeye to 40-60 cm adult sockeye or alternately at a level low enough (gain 4) that only acoustic targets equivalent to adult sockeye would be detected. These procedures along with specific aspects of echogram processing (discussed below) permitted us to obtain 10 useable sets of echograms on which to base acoustic escapement estimates for comparison with fence counts during the interval June 7 to August 17, 1984 and two additional echograms for estimates from June 29, 1983 and September 22, 1982.

Echograms from each survey were divided into up to twelve depth strata with intervals increasing with depth for visual counting. Experience quickly demonstrated that for surveys conducted with the Simrad EYM sounder at gain 10, acoustic targets the size of adult sockeye are subjected to multiple insonifications and produce characteristic inverted-v shape "signatures" on echograms. Thus, adult targets could be visually enumerated on echograms either in the presence or absence of acoustic targets due to juvenile sockeye (Fig. 4a). Echo width and intensity differences also aided in visual resolution of targets due to adult sockeye, and midwater trawling through distinctive target layers during surveys provided further circumstantial evidence that a particular target layer contained only adult sockeye, juvenile sockeye or a mixture of the two. Similar considerations indicated that when surveys were conducted at gain setting 4, only acoustic targets the size of adult sockeye were recorded (Fig. 4b). Adult sockeye were always well dispersed throughout the lake during our surveys; consequently, superimposition of acoustic targets seldom, if ever, resulted in

underestimates of their abundance. Rare exceptions to this were caused by high target densities from aggregations of juvenile sockeye which occasionally "masked" the presence of some adult targets within a stratum. However, juvenile and adult sockeye generally exhibited a marked degree of vertical segregation in the water column at night on surveys so "masking" was not routinely a problem in enumeration of adult targets.

The volume of water sampled by the sounder within a depth stratum varies both due to the conical shape of the acoustic beam (larger volumes are insonified either at greater depths or within a depth at a higher gain setting) and the variation in transect length at depth as influenced by bathymetric patterns unique to each transect. Therefore, raw counts from echograms completed for depth strata within transects have been adjusted to equivalent counts per unit volume. Means and 95% confidence intervals of abundance estimates are based on the adjusted counts for a given depth stratum from the 10-11 acoustic transects completed on each survey. The estimate of mean abundance per unit area for a given survey date is then simply the sum of the mean abundance estimates across all depth strata. Abundance estimates per unit area are finally converted into escapement estimates by scaling up to the total area of Hobiton Lake.

Biological Samples:

Sockeye samples were taken from the Indian Food Fishery (IFF) and at the Hobiton River fence. Samples were obtained intermittently throughout the course of the run (June 3 - July 6). A sample size of 100 fish taken within a single day was preferred. However, when a sample of 100 was not available on a single day, the remainder were obtained as available on subsequent days. Samples from gillnet catches were collected on 4 days from the IFF, while samples were taken on 15 days from the fence site. The number of fish in samples taken ranged from 2 to 100 sockeye. A total of 556 fish were collected for the 1984 season, 146 from the IFF and 410 from the fence site.

Individual sockeye from the IFF were examined on the fishing grounds for fork length, postorbital-hypural length and sex. Several scales were removed from each sockeye sampled for later age determination in the laboratory. Otoliths were not taken because previous studies (author's unpublished data) have indicated little deterioration of scales at the time adult sockeye return to Hobiton Lake and good agreement (93.7%) between age determinations based on scales and otoliths from the same fish.

Sampling at the fence was done during peak periods of migration (2200-0100 hr and 0600-0800 hr). Counter tunnels were blocked to impede upstream migration. When sufficient numbers of sockeye were accumulated behind the fence, they were collected with a 30 m x 2 m beach seine. Fork length and sex were recorded, and scales were removed, labelled and preserved for each fish. These live adults were then released on the upstream side of the fence.

Fork lengths and corresponding postorbital-hypural lengths obtained from individual fish were used to generate two linear regression models, one each for male and female sockeye. The resultant models were used to convert the fork lengths of individual fish sampled at the fence to postorbital-hypural lengths.

Scales were removed from an area below the insertion of the dorsal fin midway between the dorsal fin and lateral line. Scales were placed in labelled vials. Each vial contained a 50% glycerine/water solution buffered with thymol crystals. Vials were labelled for collation with age and sex data for individual sockeye. The age of individual sockeye was determined in the laboratory at the Pacific Biological Station, Nanaimo.

Environmental Observations:

Water levels and water temperatures were recorded between 0600-0800 hr and 2000-2200 hr each day (May 25 to July 14) at the fence site. Water levels were obtained from a guage (graduated in cm) attached to the fence 7 m from the log bulkhead and water temperatures were recorded by a seven day Taylor continuous recording thermograph. Daily precipitation records were obtained from the Nitinat Hatchery, approximately 6.5 km northeast of Hobiton River.

RESULTS AND DISCUSSION

SOCKEYE ABUNDANCE

The total sockeye run of the Hobiton Lake system is a combination of IFF catch, study site mortalities and escapement (corrected for machine error and bypass) (Table 1).

INDIAN FOOD FISHERY

The fishing season for Hobiton sockeye in 1984 extended, by regulation, from early May to June 21 at the rivermouth. Two days per week (0001-2400 Sunday and 0001-2400 Thursday) were designated as food fishery openings. Past experience has indicated that 50% of the returns of sockeye to Hobiton Lake can be expected as early as June 19 (Table 2), consequently we advised the Band Conservation Officer during the week of June 18 that the Hobiton run appeared to be weaker than anticipated. Further, because the escapement to June 21 was only 6,134 sockeye our advice was that fishing should be curtailed to achieve a target escapement of 15,000-20,000 adult

sockeye. At this point the Band Conservation Officer acting on behalf of the Band Council, closed the main fishery at the mouth of the Hobiton River. This fishing location did not reopen for the remainder of the season, although minor fishing activity continued until the end of June on regular opening days at Nitinat Narrows (i.e. Mud Flats).

Observations pertaining to fishing gear, techniques and effort associated with the 1984 food-fishery are as follows: Fishing gear and techniques vary according to fishing location, weather conditions, time of day, sockeye behaviour and abundance.

The majority of fish were caught by gillnets, deployed much like a seine from a power boat, and on three occasions a community drag seine was used. Gillnets measured 25-60 fathoms in length, 6 m in depth, and were constructed of nylon mesh (10.89 cm - 11.4 cm stretched measure). The drag seine was 50 fathoms in length, 6 m in depth, with a mesh size of 7.5 cm stretched measure.

Native fishermen position their boats on either side of the rivermouth with the gillnet piled onto a piece of plywood attached to the bow of the boat. One end of the net is anchored to the shore by tying the bridle to a tree, large rock, or boom chain. Fishermen observe the movements of fish, paying special attention to the direction fish are finning or jumping. When the fish are close enough to shore and are moving towards the position of the fishermen, the net is set ahead of the school of sockeye and closed against the shore behind the school. While the set is being made other band members, if present, may throw rocks in the area between the boat and shore. This "spooks" the fish away from open areas until the set is complete, thus reducing the number of sockeye that may escape. After the net is closed, band members on site will throw rocks inside the set thus "spooking" the sockeye into the gillnet. Gilled fish are removed from the net as it is pulled in and piled on the beach.

When fishing pressure is heavy the schools break up and move offshore, making the above technique ineffective. On these occasions, fishermen will join two nets together to increase the overall fishing capacity of the gear. One boat will hold the joined nets while the other boat acts as an anchor; when the time is judged to be right, the net boat lets out the net while making a wide circle around the school of sockeye, and when the two boats meet the set is completed. Because the nets cannot be completely closed, the fisherman in the net-boat repeatedly throws his oar in front of the join to keep the sockeye from escaping. During this time the other boat enters the set and drives in circles, "spooking" fish into the gill net. Once fish have ceased to hit the net, one end is picked up and the sockeye are removed as the net is retrieved.

In good weather fishermen can usually depend on sighting finning or jumping fish before making a set. When weather conditions (i.e. heavy chop) make sightings difficult, blind sets are made in front of the rivermouth.

Fishermen generally deploy their gear during the early morning hours, 0500-0900 and the evening hours, 1700-2200. If band members stay

through the night they set their nets perpendicular to the shore and retrieve fish as they hit the net.

Natives fishing at Mud Flats are restricted to deploying their gear at 'slack water', which allows them approximately 20 minutes of fishing per day (pers. comm., C. Edgar, c/o Nitinat Band Council, P.O. Box 340, Port Alberni, B.C.). Gillnets are set perpendicular to the shoreline.

Sixteen band members participated in the fishery during the 1984 season. Landings were reported on 16 days for the rivermouth fishery from May 30 to June 21. The IFF catch per individual was variable, throughout the monitoring period with fishermen reporting anywhere from no catch to a high of 110 pieces (June 21) (Table 3). The amount of effort expended by band members was dependent on the amount of sockeye activity in the vicinity of the rivermouth. For example, if there were limited sightings of fish a band member might spend two hours at the rivermouth, making only one or two sets before returning to the village on the reserve (Fig. 1). The amount of gear being deployed from motorboats on a food fishery day varied from 1 to 7 nets (Table 3).

During the period prior to daily monitoring of the IFF, approximately 73 sockeye were caught (April 1-May 29) (pers. comm., J. Edgar). From May 30 to June 21 a total of 556 sockeye were landed at the river mouth and 110 pieces of sockeye at Mud Flats (Fig. 5a). After June 21 a total of 39 sockeye were caught at Mud Flats. No landings were reported after June 26. Monitoring of the IFF ceased on July 5. The community drag seine was used at the river mouth on July 11 and 19 with no landings reported (pers. comm., J. Edgar, Nitinaht Band Council, P.O. Box 340, Port Alberni, B.C.).

The reported total catch for 1984 was 778 sockeye. Daily catch is summarized in Table 1. Catch statistics obtained through interviews and personal observations indicate that daily landings fluctuated a great deal (Fig. 5a).

ESCAPEMENT AT THE HOBITON FENCE

Daily escapement values for sockeye entering Hobiton Lake in 1984 consist of the sum of the hourly machine counts (corrected for machine counting error) and fish observed to have bypassed the counting tunnels. The electronic fish counter was in operation from May 25 to July 14 inclusive; however, supplementary visual counts extended the interval over which the escapement was assessed from April 10 to July 14 inclusive.

The Pulsar electronic fish counter (model 289) performed well at the Hobiton fence site during the 1984 season; however, as in past years, the machine counts were not totally accurate relative to simultaneous visual counts (Appendix 1). We used regression analysis to examine a number of

alternative models for application to calibration of machine fish counts (treated as the independent variable) relative to visual counts (Table 4). Our results suggested that machine counts were significantly density dependent, although the deviation from linear behaviour was so small as to be inconsequential in choosing either a density dependent or linear model for correction of the machine count data set. The intercept of the linear model (mch = a + bvch) was not significantly different from zero ($p = .078$). Consequently, for computational ease, we used the simple linear model mch = .986 vch here (Fig. 6) to correct machine count data (Appendix 3).

Sockeye sampled on the downstream side of the counting fence and released alive on the upstream side as well as fish that managed to move upstream of the counting fence without passing through tunnels to the electronic counter were recorded as bypass counts (Table 1). Daily bypass counts were added to the daily sum of the adjusted machine counts to yield a total daily escapement estimate (Table 1). Machine count adjustments and bypass counts increased the 1984 escapement estimate by 6.2%. The sum of all the daily estimates indicated that 11,516 sockeye entered Hobiton Lake to spawn in 1984.

During the 51 days over which the electronic fish counter was operated at Hobiton Lake in 1984 (May 25 - July 14), returns of adult sockeye did not monotonically build to or decline from a clearly defined peak. Counts of adult fish accumulated at a fairly steady rate of between 100 and 500 fish/day (48 out of 51 days) (Fig. 5b). Escapements of greater than 500 fish/day occurred on only 3 scattered dates (June 10, 24 and 27). This pattern of escapement returns is consistent with that observed in past years where small groups of fish appeared to arrive at 3-5 day intervals throughout the period from late May to early July (author's unpublished data) and 50% of the run had returned by the 3rd to 4th week of June. Although visual observations indicated that adult returns to Hobiton Lake had begun prior to electronic counter installation, the number of fish missed during the early part of the 1984 run was small since total visual enumeration between April 10 and May 21 inclusive resulted in only 33 adult sockeye sightings at the fence (<1% of the total escapement enumerated). Eight consecutive days of decline in the numbers of adult sockeye appearing at the fence occurred after July 6 such that on July 14 only 33 adult sockeye were enumerated, after which the counter and fence were removed. Hydroacoustic estimates of adult sockeye present in Hobiton Lake in August of 1984 and September of 1982 (see results and Table 5) suggest that fence counts to the end of the 1st week of July are useable as final escapement estimates.

ENVIRONMENTAL OBSERVATIONS

During the interval of adult sockeye migration, water temperature ranged from a low of 11.3 degrees Celsius on May 26 to a high of 19.3 degrees Celsius on June 25 (Fig. 7 and Appendix 5). Measurable precipitation, recorded at the Nitinat hatchery, occurred on approximately 19 of the 51 days

during which adult sockeye were counted passing the Hobiton weir. In general precipitation during the latter part of May and in early June was not of sufficient magnitude to prevent water levels in the river from dropping from the seasonal highs of late winter and early spring (Fig. 7). However six days of heavy precipitation after June 24 (25.8 mm of rain fell on June 27) resulted in a rapid and dramatic rise in mean water level in the Hobiton River. Regardless, examination of daily changes in the number of sockeye migrants suggests little association between variations in these environmental factors and variations in the number of sockeye passing upstream into Hobiton Lake (Fig. 7).

HYDROACOUSTIC ESTIMATES OF ESCAPEMENT

On most of our acoustic surveys the majority of adult sockeye were detected within 5-30 m of the lake surface (Table 5). As might be expected, the precision of acoustically based escapement estimates was relatively low when small numbers of adult sockeye were in the lake but increased as the number of adults in the escapement increased (Table 5). Comparisons for accuracy indicated that errors on acoustic estimates relative to fence counts ranged from as little as 1.7% (Aug. 17, gain 10, Table 4) to as much as 66% (July 14, 1984). The latter comparison illustrates the importance of selecting an appropriate gain setting during surveys for acoustic estimates of adults. The survey of July 14, 1984 was mistakenly completed at gain setting 5, which was high enough to detect a portion of the juvenile sockeye population as acoustic targets but not high enough to permit unequivocal discriminations between acoustic targets produced by adults and juveniles. This problem was further complicated by poor vertical segregation of adult and juvenile sockeye on this date. Consequently, we seriously overestimated the size of the adult population from this survey relative to the cumulative weir count.

For analytical purposes here, we have assumed weir counts to be without error, thus allowing the use of standard least squares procedures for estimating the bias inherent in our acoustic estimates. This analysis clearly indicates that most of the variation in the numerical values of our 12 acoustic estimates may be accounted for on the basis of changes in the cumulative number of adult sockeye that had entered Hobiton Lake through the fence site ($r2 = 0.97$, $p < 0.001$, $n = 12$, Fig. 8). The non-zero intercept of this relationship is not surprising and, given acoustic estimates completed over an approximately 20 fold change in the magnitude of the independent variable, is likely a meaningful indicator of the existence of a small population of approximately 1500 relatively large-bodied resident fish, other than sockeye, in the lake.

These results indicate that our acoustic estimates are not only useful as a relative index of the magnitude of sockeye escapement to Hobiton Lake but that their accuracy is generally high as well. Comparison of our results to those of other studies indicates that this will not always be the case. For example, Mulligan and Kieser (1985, in prep.) used hydroacoustic

techniques to estimate the Long Lake adult sockeye population over a 4 day interval in 1982 and found that eight independent acoustic estimates produced a mean escapement value (121,000 ± 8,600), based on echo-counting procedures similar to ours, that was only 58% of the cumulative weir count (210,000 ± 857). These authors used a more elaborate configuration of acoustic gear than ours and deployed it in a large aluminum herring skiff equipped with a gasoline generator and driven by an outboard motor to complete their surveys. Mulligan (pers. comm., Pacific Biological Station, Nanaimo, B.C.) has expressed the opinion that adult sockeye may have moved out of the path of the acoustic transects at Long Lake due to the noise associated with survey execution. This was not an important consideration on our surveys since the acoustic gear relied on a 12 volt car battery for power and was deployed from a sound muffling rubber boat driven by a small (7.5 - 20 hp), relatively quiet outboard motor.

TOTAL STOCK RETURNS

The total stock of 12,383 sockeye that returned to Hobiton Lake during 1984 was split among Indian food-fish catch, escapement and mortalities at the counting fence (Table 6). Because the Indian food-fish catch was only 6.3% of the total returns and it was taken intermittently throughout the run (Fig. 5a), the seasonal pattern of total stock returns (Fig. 5c) was largely indistinguishable from that described above for the escapement. The estimate of total stock should be considered conservative. Some adult sockeye undoubtedly entered the lake after the fence was removed on July 14, although hydroacoustic estimates (Table 5) suggest that it is unlikely that this would have involved more than a few hundred adults. In addition, although considerable effort was expended to collect catch statistics, some catch from locations along the migration route in Nitinat Lake likely continues to go unreported. There was also an increase in the chance that Hobiton sockeye would have been intercepted further north off Barkley Sound during 1984. From June 7 through late July an unprecedented number of gillnetters and purse seiners participated in the Barkley Sound and Alberni Canal sockeye fishery. The sheer number of vessels resulted in a tendency for a portion of the gillnet fleet to fish in areas further seaward than in past years (Steer et al. 1985; D. McCulloch, Dept. of Fisheries and Oceans, Port Alberni, B.C.), thus increasing the prospects for interception of Hobiton adults which must pass Barkley Sound upon their return.

Diel Migration Patterns

A series of 20 days (May 28, 29; June 6, 11, 12, 18, 25; July 1-13) of hourly machine counts at the fence were pooled to determine the general diel migration pattern of adult sockeye up the Hobiton River when no IFF catch was reported and fishery interference was assumed to be non-existent. The estimated number of migrant sockeye appearing during each of the 20 days ranged from 4-360 and for all days combined totalled 3,235 fish (28.2% of the escapement). Another series of 10 days (May 30, 31; June 1, 2, 7, 8, 10, 14, 24, and 26) of hourly counts were pooled to examine the diel migration pattern

at times when the IFF took up to 25% of the daily run and may have interfered with the normal pattern of migration. The estimated number of migrant sockeye appearing during each of these 10 days ranged from 42-1,291 and for all days combined included 4,487 fish (39.0% of the escapement). All hourly observations were adjusted for machine error and then the diel migration patterns for days when data were pooled were determined as:

$$\bar{x}j = \frac{\sum_{i=1}^{n} xij}{\sum_{i=1}^{n}\sum_{j=1}^{24} xij} \times 100$$

where: xj = percent of migrants at a given hour for all days combined,

xij = number of migrants observed in day i and hour j,

$\sum_{i=1}^{n} xij$ = total number of migrants at a given hour for all days combined,

and $\sum_{i=1}^{n}\sum_{j=1}^{24} xij$ = total number of migrants for all days combined.

In the absence of any disturbance from a fishery, diel migration by sockeye was continuous with some fish moving during each hour of the day (Fig. 9a). However, it is also apparent that the majority of fish ascended the river during the night, as more than 70% of all sockeye passed the fence between 2000 and 0500 hrs. Less than 10% of the fish migrated between mid-morning (1000 hrs) and early evening (2200 hrs). Migration patterns on most individual days adhered to the general pattern, although significant departures from the more general pattern were associated with some dates (e.g. Fig. 10, June 18, July 3-4).

During the interval when the Indian Food Fishery was active, the diel migration pattern was more variable and included a mid-afternoon to early evening pulse of fish moving past the fence (Fig. 9b). This latter feature is likely coincidental with, rather than a result of, the Indian Food Fishery. The daylight pulse of migration was primarily attributable to the relatively large number of fish (2,537) migrating on just two days (June 10, 24) during which the food fishery was also active. The catch on these two days amounted to only 65 fish (Table 1); consequently it is difficult to understand how this modest level of fishing activity could offer an explanation for an increased level of daylight migration by adult sockeye. An alternative explanation is that the number of adult sockeye that arrive at the mouth of the Hobiton River on a given day influences their patterns of diel migration; that is, small numbers of adult sockeye arriving at the rivermouth generally wait until dark

to make their ascent while large numbers of adults interact differently to complete the ascent from rivermouth to lake during daylight hours. During 1984, for the two dates on which more than 1000 sockeye passed the fence, 93% of the fish ascended during the day. By contrast for all dates (n = 32) on which more than 50 but less than 300 adult sockeye passed the fence, only 21% on average ascended the river during the day.

BIOLOGICAL CHARACTERISTICS

Biological Samples for Age and Size Composition:

A total of 19 daily samples containing between 2 and 100 sockeye per sample were obtained from either the Indian Food Fishery (4 samples) or from the counting fence (15 samples) during the interval from June 3 to July 6 (Table 7). Although a total of 556 adult sockeye (4.5% of the estimated total stock) were measured and sampled for scales, only 528 were unequivocally aged on the basis of scale readings in the laboratory. Results from these samples have been used to calculate the age and sex composition of the Hobiton run weighted by abundance.

The procedure used to assign sample age and sex composition results to represent a given portion of the run was as follows. Daily samples obtained within each of 5 separate calendar weeks (June 3-9, 10-16, 17-23, 24-30 and July 1-7) were initially assumed to represent 5 sample groups (Table 7). A one way ANOVA procedure for unbalanced data (SAS, general linear models procedures) was used to test for significant differences in the mean size of fish among samples, within groups i.e. H0: s1 = s2 = s3 . . . sn, where s = sample. The null hypothesis was rejected if one significant difference among sample means within a group was detected. To further determine which pairs of samples were different, Scheffes multiple comparison procedure was used (Table 9) and this permitted us to identify which samples should be pooled and which to treat separately in assigning size and age determinations to a given portion of the run. If no significant differences were detected then all samples within a group were pooled to represent the size, age and sex composition of the portion of the total run returning in the calendar week during which the samples were obtained.

The hypothesis of equality of sample means within groups was rejected for samples belonging to samples (i.e. calendar weeks) 2, 3 and 5 while pooling of sample results appeared warranted with respect to sample groups 1 and 4 (Table 8). Application of Scheffes test recommended that our 5 original sample groups be repartitioned into 8 homogeneous groups, each representing a specific portion of the Hobiton run (Tables 7 and 10). Sample sizes of fish within these new groups ranged from 14 to 117 and were used to derive a weighted estimate of the age and sex composition of from 1.0 to 25.5% of the total stock.

The weighted age and sex composition estimates (Table 9) were calculated according to:

$$x = (r/R * n/N) * 100$$

where: x = % of a given age and sex
r = catch + escapement for the sample period
R = total stock size
n = number of sockeye of a particular age and sex in the sample
N = sample size

Adult sockeye sampled at Hobiton Lake during 1984 were represented by 5 of 6 possible age-at-return combinations (Table 10). Four-year-old fish (1.2) dominated returns in all 8 calendar intervals and represented 78.5% of the total return. Five-year-old fish (1.3 and 2.2) comprised 21.1% of the stock. The remaining 0.5% included jacks (1.1) and six-year-olds (2.3).

Two independent estimates of the proportion of jacks (1.1) contained in the run are available. Jacks were determined to make up 0.32% of the run total on the basis of weighted age composition assignment from samples of adult sockeye manually processed at the fence. The proportion of jacks was also determined from visual observations of large (non-jack) and small fish (jacks) passing through the fence during machine calibration periods (June 10 - July 9). Jacks were visually recorded on 7 days during the run and they made up 3.17% of the 1072 sockeye observed (Table 11) on these days only or 0.27% of the total stock.

The weighted sex composition of the 1984 escapement was 50.9% males and 49.1% females (Table 10).

Size Composition:

To maintain consistency with biological sample data from previous years (e.g. Manzer et al. 1984) fork lengths of adult sockeye sampled at the Hobiton River fence were converted to postorbital-hypural length according to the linear regression formulae:

		N	$\bar{X}$L	SD	SE	R^2
Males						
HL = 27.978 + 0.768*FL		108	422.02	9.28	0.89	0.92
Females		N	$\bar{X}$L	SD	SE	R^2
HL = -5.005 + 0.842*FL		88	413.65	8.97	0.96	0.92

where HL = postorbital-hypural length (mm) and FL = fork length (mm). The biological information used to generate the linear regression formulae was obtained from IFF samples and study site mortalities (Fig. 11).

The sockeye length frequency distributions by age class and sex indicate that there is considerable overlap in size distribution of both male and female age 1.2 and 1.3 sockeye (Fig. 12). However, no significant difference in mean length exists between sexes of the same age class (Table 12).

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Table 1. Daily statistics on machine counts (adjusted for error), bypass and mortalities of adult sockeye at the Hobiton fence, 1984. Daily escapements are the sum of adjusted machine counts and bypass. Indian food fish catch (IFF) was taken primarily at the mouth of the Hobiton River and, when added to escapement and mortality estimates, provides an estimate of total stock.

Date	Daily adjusted machine totals	Bypass	Daily escapement (machine totals and bypass)	Mortalities	IFF catch	Total stock (catch + escapement)	
						Daily	Accum
19/04	0	3	3	1	--	4	4
21/04	0	2	2	0	--	2	6
27/04	0	0	0	6	--	6	12
02/05	0	1	1	9	--	10	22
03/05	0	1	1	0	--	1	23
11/05	0	1	1	0	--	1	24
20/05	0	0	0	0	--	0	24
21/05	0	9	9	0	--	9	33
25/05	0	0	0[a]	0	--	0	33[a]
26/05	24	0	24	1	N	25	58
27/05	27	0	27	1	N	28	86
28/05	27	0	27	5	--	32	118
29/05	4	15[b]	19	0	73[e]	92	210
30/05	382	89[b]	471	0	38	509	719
31/05	40	2[b]	42	0	8	50	769
01/06	398	18[b]	416	0	8	424	1193
02/06	153	1[b]	154	0	26	180	1373
03/06	146	26[d]	172	5	N	177	1550
04/06	218	52[d]	270	4	N	274	1824
05/06	103	2[d]	105	0	38	143	1967
06/06	298	0	298	8	N	306	2273
07/06	262	1[c]	263	2	19	284	2557
08/06	153	0	153	0	12	165	2722
09/06	36	0	36	0	37	73	2795
10/06	1246	4[b]	1250	0	61	1311	4106
11/06	184	0	184	0	N	184	4290
12/06	358	0	358	0	N	358	4648
13/06	154	4[b]	158	0	N	158	4806
14/06	206	0	206	1	51	258	5064
15/06	122	0	122	0	N	122	5186
16/06	83	92[d], 32[b]	207	10	N	217	5403
17/06	275	8[b]	283	0	134[f]	417	5820
18/06	184	1[c]	185	1	N	186	6006
19/06	295	5[b]	300	0	N	300	6306
20/06	238	18[d]	256	0	N	256	6562
21/06	131	0	131	0	234	365	6927
22/06	18	16[d]	34	0	N	34	6961

Table 1 (cont.)

Date	Daily adjusted machine totals	Bypass	Daily escapement (machine totals and bypass)	Mortalities	IFF catch	Total stock (catch + escapement) Daily	Accum
23/06	88	0	88	0	N	88	7049
24/06	1292	0	1292	0	4[b]	1296	8345
25/06	118	0	118	0	N	118	8463
26/06	355	0	355	0	35[g]	390	8853
27/06	643	24[d]	667	1	N	668	9521
28/06	297	25[d]	322	0	N	322	9843
29/06	171	45[d]	216	0	N	216	10059
30/06	147	0	147	0	N	147	10206
01/07	360	0	360	0	N	360	10566
02/07	213	13[b]	226	15	N	241	10807
03/07	164	1[d]	165	12	N	177	10984
04/07	158	11[d], 3[b]	172	4	N	177	11161
05/07	145	2[b]	147	0	N	147	11308
06/07	323	16[d]	339	0	N	339	11647
07/07	190	2[b]	192	0	N	192	11839
08/07	151	0	151	0	N	151	11990
09/07	124	0	124	0	N	124	12114
10/07	78	0	78	0	N	78	12192
11/07	57	0	57	0	0	57	12249
12/07	35	0	35	0	N	35	12284
13/07	64	1[b]	65	3	N	68	12352
14/07	33	0	33	0	N	33	12385
19/07	--	--	--	--	0	--	12385
Total	10971	546	11517	89	778		12385

[a]Sockeye enumerated visually from April 10 to May 25, 1984.

[b]Sockeye that bypassed the counter tunnels.

[c]Sockeye that were caught in the fence and released; and

[d]Sockeye that were sampled on the downstream side of the fence and released on the upstream side.

[e]A total of 73 sockeye were caught before May 30 (J. Edgar, pers. comm.).

[f]Of the 134 sockeye caught, 110 were caught at Nitinat Narrows (C. Edgar, pers. comm.).

[g]Caught at Nitinat Narrows.

IFF Codes: 0 = no catch even though fishing occurred.
numeric = catch while fishing.
N = no fishing (therefore no catch).

Table 2. A summary of the dates to 50% return of Hobiton sockeye in five recent brood years.

Brood year	Date to 50% return	No. to 50% return
1980	July 3	4,816
1981	June 20	11,981
1982	June 26	38,160
1983	June 19	15,385
1984	June 19	6,193

Data sources: author's unpublished data and Manzer et al. 1984.

Table 3. Summary of the Indian Food Fishery catch associated with effort, 1984.

Date	Location	Number of boats and size	Number of fishermen	Total person hours expended[2]	Gear type	Number of sets[b]	Soak-time	Catch
30/05	Rivermouth	1 - 14' with 25 H.P. outboard	1	>2 and <6	Gillnet (25 fathoms, 10.3 cm stretch mesh)	>1 and <10	N/A	38
31/05	Rivermouth	1 - ~18' with 25 H.P. outboard	1	~4	Gillnet (50 fathoms, 11.4 cm stretch mesh)	N/A	1800-2200	8
01/06	Rivermouth	1 - ~18' with 25 H.P. outboard	2	>2 and <6	Gillnet (50 fathoms, 11.4 cm stretch mesh)	N/A	2000-> ?	8
02/06	Rivermouth	2 - 14' with 25 H.P. outboard & 14' with 9.9 H.P. outboard	2	~8	Gillnets - 1 - 60 fathom, 11.3 cm stretch mesh; 2 - 25 fathom, 10.8 cm stretch mesh)	>2 and <10	N/A	1 25
05/06	Rivermouth	1 - 14' with 25 H.P. outboard	1	>2 and <6	Gillnet (25 fathoms, 10.8 cm stretch mesh)	>1 and <10	N/A	38
07/06	Rivermouth	1 - 14' with 25 H.P. outboard	1	3	Gillnet (25 fathoms, 10.8 cm stretch mesh)	2	N/A	19
09/06	Rivermouth	3 - 2 at 14' with 9.9 H.P. outboards 1 at 18' with 25 H.P. outboard	3	~45	Gillnets (2 at 25 fathoms, 10.8 cm stretch mesh; 1 at 50 fathoms, 11.4 cm stretch mesh)	~6	0900-2400	10 12 15

Table 3 (cont.).

Date	Location	Number of boats and size	Number of fisher-men	Total person hours expended[2]	Gear type	Number of sets[b]	Soak-time	Catch
10/06	Rivermouth	3 - 2 at 14' with 9.9 H.P. outboards 1 at 18' with 25 H.P. outboard	3	~9	Gillnets (2 at 25 fathoms, 10.8 cm stretch mesh; 1 at 50 fathoms, 11.4 cm stretch mesh)	>3	0000-0700	28 33 0
14/06	Rivermouth	5	6	~30	Gillnets (2 at 25 fathoms, 10.8 cm stretch mesh; 2 at 50 fathoms, 11.4 cm stretch mesh; 1 at 60 fathoms, 11.4 cm stretch mesh)	~12	1930-> ?	22 14 7 5 3
17/06	Rivermouth	4 - 3 at 14' with 9.9 H.P. outboards 1x 14' with 25 H.P. outboard	4	>8 and <24	Gillnets (2 at 25 fathoms, 10.8 cm stretch mesh; 2 at 50 fathoms, 11.4 cm stretch mesh)	>4 and <48	N/A	21 3 0 0
	Mud Flats[a]	3 - 1 at 18' with 25 H.P. outboard 2 at 25' with 50 H.P. outboard	3	20 min.	Gillnets (1 at 50 fathoms, 11.4 cm stretch mesh; 2 at 60 fathoms, 11.4 cm stretch mesh)	N/A	20 min.	10 (100)[c]

Table 3 (cont.).

Date	Location	Number of boats and size	Number of fisher-men	Total person hours expended[2]	Gear type	Number of sets[b]	Soak-time	Catch
21/06	Rivermouth	7	8	>16 and <48	Gillnets (1 at 25 fathoms, 10.8 cm stretch mesh; 3 at 50 fathoms, 11.4 cm stretch mesh; 2 at 60 fathoms, 11.4 cm stretch mesh)	>6 and <76	N/A	110 10 0 1 38 0
					Seine - 1 at 50 fathoms, 6.5 cm stretch mesh	2	N/A	75
24/06	Nitinat Narrows[a]	1	1	<20 min.	Gillnet - 50 fathoms, 11.4 cm stretch mesh)	1	<20 min.	4
26/06	Nitinat Narrows	1	1	<20 min.	Gillnet - 60 fathoms, 11.4 cm stretch mesh)	1	<20 min.	35
11/07	Rivermouth	1	1	4	Gillnet - 25 fathoms, 10.8 cm stretch mesh)	N/A	1800-2200	0
19/07	Rivermouth	1	2	>2 and <6	Seine - 50 fathoms, 6.5 cm stretch mesh)	1	N/A	0

[a]Natives can set their nets at slack water only. Slack water occurs midway between h and low tide. In Nitinat Narrows, slack water occurs when the coast tide has the same elevation as the lake.

[b]Because native fishermen usually depend on sightings of finning or jumping sockeye, number of sets and time spent at the rivermouth will depend on how much fish activity there is. If there is no activity then it is unlikely a fisherman will spend more than two ho at the rivermouth.

[c]Accumulated catch to date at Mud Flats.

Table 4. Regression equations for calibration of electronic fish counts per hour (mch) to visual count equivalents (vch). Sample size = n, a + b are fitted parameters.

Model	n	r^2	a	b	
$mch = a(vch + 1)^b - 1$ (non-linear)	78	1.00	.002	.998	p(b=1)<.001
mch = a + bvch (linear with non-zero intercept)	78	.99	.111	.985	p(a=o)=.078
mch = bvch (linear with zero intercept)	78	.99	-	.986	p(b=1)<.001

Table 5. A comparison of hydroacoustic estimates of escapement into Hobiton Lake with cumulative counts of escapement to a given date at the counting fence, 1984.

Date	Day or Night	Gain and Beam Width	Number of Transects	Depth Interval(m) Containing >90% of Adult Targets	Escapement Estimates by Acoustics	95% Confidence Interval	Escapement by Fence Count	Comments
07/06	N	10 (20 deg)	11	10 - 20	1,890	± 1,079	2,305	
12/06[a]	D	6 (20 deg)	10	10 - 40	3,752	± 2,488	4,286	
13/06	N	10 (20 deg)	11	5 - 20	2,758	± 1,308	4,444	
18/06	N	10 (20 deg)	11	5 - 15	6,237	± 1,764	5,447	
29/06	N	10 (20 deg)	11	5 - 20	9,073	± 2,622	9,226	
05/07	N	10 (20 deg)	11	5 - 20	9,568	± 2,954	10,443	
13/07	N	10 (20 deg)	11	10 - 30	8,823	± 3,187	11,483	Some adult targets obscured by dense juvenile targets
14/07[b]	N	5 (13 deg)	11	10 - 20	19,081	± 4,369	11,516	Windy, blown off transects
17/08	N	4 (13 deg)	11	10 - 30	13,410	± 3,914	11,516	
17/08	N	10 (20 deg)	11	10 - 30	12,140	± 2,582	11,516	
22/09/82	N	4 (13 deg)	11	15 - 40	43,132	± 8,204	49,432	
29/06/83	N	4 (13 deg)	10	5 - 15	18,677	± 6,843	17,959	

[a]Windy, blown off transects. The corrected beam width for Gain 6 was not used in calculating this estimate. A 20 degree beam width was used; therefore, estimate will be low.

[b]This survey was run at Gain 5 - this setting was too high and juvenile targets were showing. Juvenile targets cannot be distinguished from adult targets at this gain setting; therefore the acoustic estimate of adults will be high.

Table 6. Fate of sockeye (O. nerka) returning to Hobiton Lake during 1984.

	No. of fish	%
Indian food fish catch	778	6.3
Escapement	11,516	93.0
Fence mortalities	89	0.7
Total stock	12,383	100.0

Table 7. Date, location and size of samples of adult sockeye used to characterize the size, age and sex composition of the Hobiton returns, 1984. Samples were obtained either from the Indian Food Fishery (IFF) at the mouth of the Hobiton River or from the counting fence at the outlet of Hobiton Lake.

Group	Sample date and number	Representative escapement period	Sample size	Pooled sample	Sample type
1	June 3 - 01	25/05/84 - 09/06/84	31		Fence
	4 - 02	25/05/84 - 09/06/84	55		Fence
	5 - 03	25/05/84 - 09/06/84	2	100	Fence
	6 - 04	25/05/84 - 09/06/84	8		Fence
	7 - 05	25/05/84 - 09/06/84	4		Fence
2	June 10 - 06	10/06/84 - 14/06/84	33		IFF
	14 - 07	10/06/84 - 14/06/84	13	46	IFF
3	June 16 - 08	15/06/84 - 16/06/84	100	100	Fence
4	June 17 - 09	17/06/84 - 21/06/84	20		IFF
	20 - 10	17/06/84 - 21/06/84	18	118	Fence
	21 - 11	17/06/84 - 21/06/84	80		IFF
5	June 22 - 12	22/06/84 - 23/06/84	16	16	IFF
6	June 27 - 13	24/06/84 - 30/06/84	25		Fence
	28 - 14	24/06/84 - 30/06/84	25	100	Fence
	29 - 15	24/06/84 - 30/06/84	50		Fence
7	July 2 - 16	01/07/84 - 02/07/84	15	15	Fence
8	July 3 - 17	03/07/84 - 14/07/84	11		Fence
	July 4 - 18	03/07/84 - 14/07/84	18	43	Fence
	July 6 - 19	03/07/84 - 14/07/84	14		Fence

Table 8. Mean body size (orbital-hypural length in mm) for each of 19 samples of Hobiton adult sockeye obtained during 1984 and results of a one-way ANOVA to test for equality of sample means for samples obtained within each of 5 calendar weeks.

Test group	Sample No.	Sample size	Mean hypural length	F-value	Conclusions
1	S-1	31	392.4	F=0.17	Accept
(June	S-2	55	391.8	F0.05(1)4,95=	HO:S1=S2=S3=S4=S5
3-9)	S-3	2	383.5	2.46	
	S-4	8	390.0		
	S-5	4	403.0		
2	S-6	33	439.7	F=16.58	Reject
(June	S-7	13	432.0	F0.05(1)2,143=	HO:S6=S7=S8
10-16)	S-8	100	404.0	3.06	
3	S-9	20	417.3	F=2.91	Reject
(June	S-10	18	416.0	F0.05(1)3,130=	HO:S9=S10=S11=S12
17-23)	S-11	80	423.6	2.67	
	S-12	16	399.0		
4	S-13	25	398.7	F=0.49	Accept
(June	S-14	25	394.8	F0.05(1)2,97=	HO:S13=S14=S15
24-30)	S-15	50	402.2	3.09	
5	S-16	15	376.3	F=4.09	Reject
(July	S-17	11	414.1	F0.05(1)3,54=	HO:S16=S17=S18=S19
1-7)	S-18	18	386.9	2.77	
	S-19	14	389.8		

Table 9. Summary of within group sample pairs for which Scheffe's test indicated mean body size was significantly ($\alpha = 0.05$) different, 1984. Groups were defined by calendar week and samples were numbered consecutively. See text for further explanation.

Group and (samples)	Significantly different sample pairs	Differences between means (mm)
2 (6 - 8)	6 - 8,	35.69
	7 - 8	27.92
3 (9 - 12)	11 - 12	24.59
5 (16 - 19)	16 - 17	37.76

Table 10. Temporal variation in age * and sex composition of Hobiton river sockeye salmon, 1984 (g-net = gillnet)

Sampling date & #	Group	Repres. period	Gear	Catch+ escape+ bypass	ABUNDANCE BY AGE AND SEX 1.1 F	1.1 M	1.2 F	1.2 M	1.3 F	1.3 M	2.2 F	2.2 M	2.3 F	2.3 M	TOTAL F	TOTAL M	TOTAL F+M	TOTAL %F
030684-	(1)	250584-	FENCE	2765#	0	0	.34	.44	4	7	5	5	0	0	43	56	99	
070684		090684		%	0.00	0.00	7.68	9.93	0.90	1.58	1.13	1.13	0.00	0.00	9.71	12.64	22.35	43.43
1-5																		
100684 6	(2)	100684-	G NET	2272#	0	0	14	14	6	8	1	2	0	0	21	24	45	
140684 7		140684		%	0.00	0.00	5.71	5.71	2.45	3.26	0.41	0.82	0.00	0.00	8.57	9.79	18.36	46.67
160684 8	(3)	150684-	FENCE	340#	0	0	37	40	9	6	1	3	1	0	48	49	97	
		160684		%	0.00	0.00	1.05	1.13	0.25	0.17	0.03	0.08	0.03	0.00	1.36	1.39	2.75	49.48
170684 9	(4)	170684-	G NET	1524#	0	0	30	51	10	22	3	0	0	1	43	74	117	
200684 10		210684		%	0.00	0.00	3.16	5.37	1.05	2.32	0.32	0.00	0.00	0.11	4.53	7.79	12.32	36.75
210684 11																		
220684 12	(5)	220684-	G NET	122#	0	1	5	8	0	2	0	0	0	0	5	11	16	
		230684		%	0.00	0.06	0.31	0.49	0.00	0.12	0.00	0.00	0.00	0.00	0.31	0.68	0.99	31.25
270684 13	(6)	240684-	FENCE	3159#	0	1	47	39	6	3	1	0	0	0	54	43	97	
280684 14		300684		%	0.00	0.26	12.37	10.27	1.58	0.79	0.26	0.00	0.00	0.00	14.21	11.32	25.53	55.67
290684 15																		
020784 16	(7)	010784-	FENCE	603#	0	0	10	3	0	0	1	0	0	0	11	3	14	
		020784		%	0.00	0.00	3.48	1.04	0.00	0.00	0.35	0.00	0.00	0.00	3.83	1.04	4.87	78.57
030784 17	(8)	030784-	FENCE	1587#	0	0	25	11	2	2	1	2	0	0	28	15	43	
040784 18		140784		%	0.00	0.00	7.46	3.28	0.60	0.60	0.30	0.60	0.00	0.00	8.35	4.47	12.83	65.12
060784 19																		
				#	0	2	202	210	37	50	13	12	1	1				
				%	0.00	0.32	41.21	37.23	6.84	8.84	2.79	2.63	0.03	0.11				
			TOTAL	12372#	2		412		87		25		2		253	275	528	
				%	0.32		78.45		15.68		5.42		0.13		50.87	49.13	100	

*Age is designated according to the European system. The first digit represents the number of annuli formed during freshwater residence; the second digit, the number of annuli formed during ocean residence.

Table 11. Incidence of "jack" sockeye salmon at the Hobiton river fence, 1984

Date	Visual total escapement	Total # of jacks	%Jacks
June 10	201	1	0.5
18	122	3	2.5
27	510	17	3.3
July 3	43	1	2.3
7	79	6	7.6
8	70	4	5.7
9	47	2	4.3
Total	1072	34	3.17

Table 12. A summary of mean body size (orbital-hypural length mm) of Hobiton adult sockeye by sex and age during 1984

		Hypural length (MM)			
		N	Mean	STD	STDERR
Sex	Reconciled age				
F	1.2	210	392.58	25.32	1.75
	1.3	38	458.10	23.24	3.77
	2.2	15	397.35	31.67	8.18
	2.3	1	436.81		
M	1.1	2	289.21	10.86	7.68
	1.2	216	396.75	22.27	1.51
	1.3	51	461.08	21.52	3.01
	2.2	12	393.97	19.71	5.69
	2.3	1	500.00		

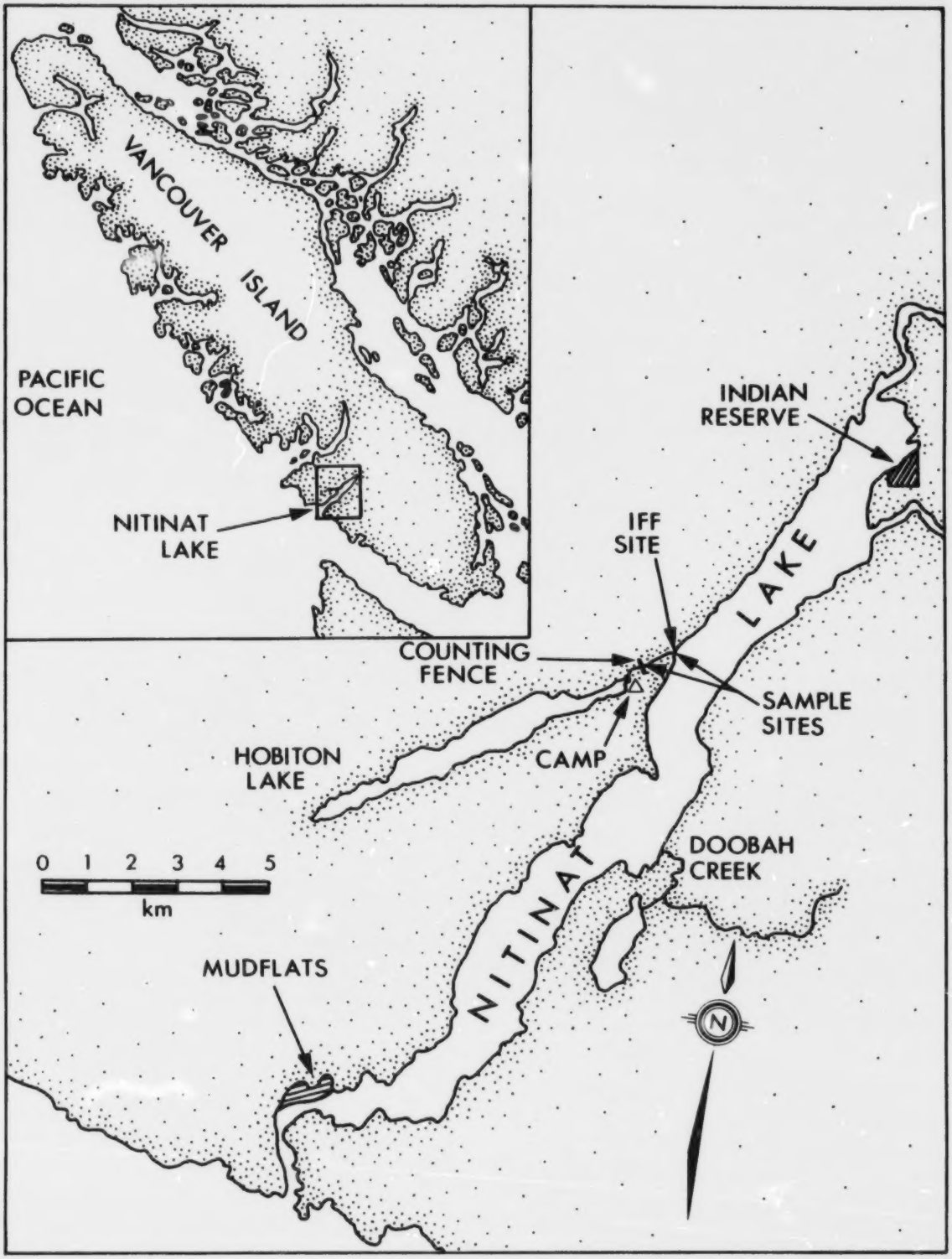

Fig. 1. Hobiton Lake study area, 1984.

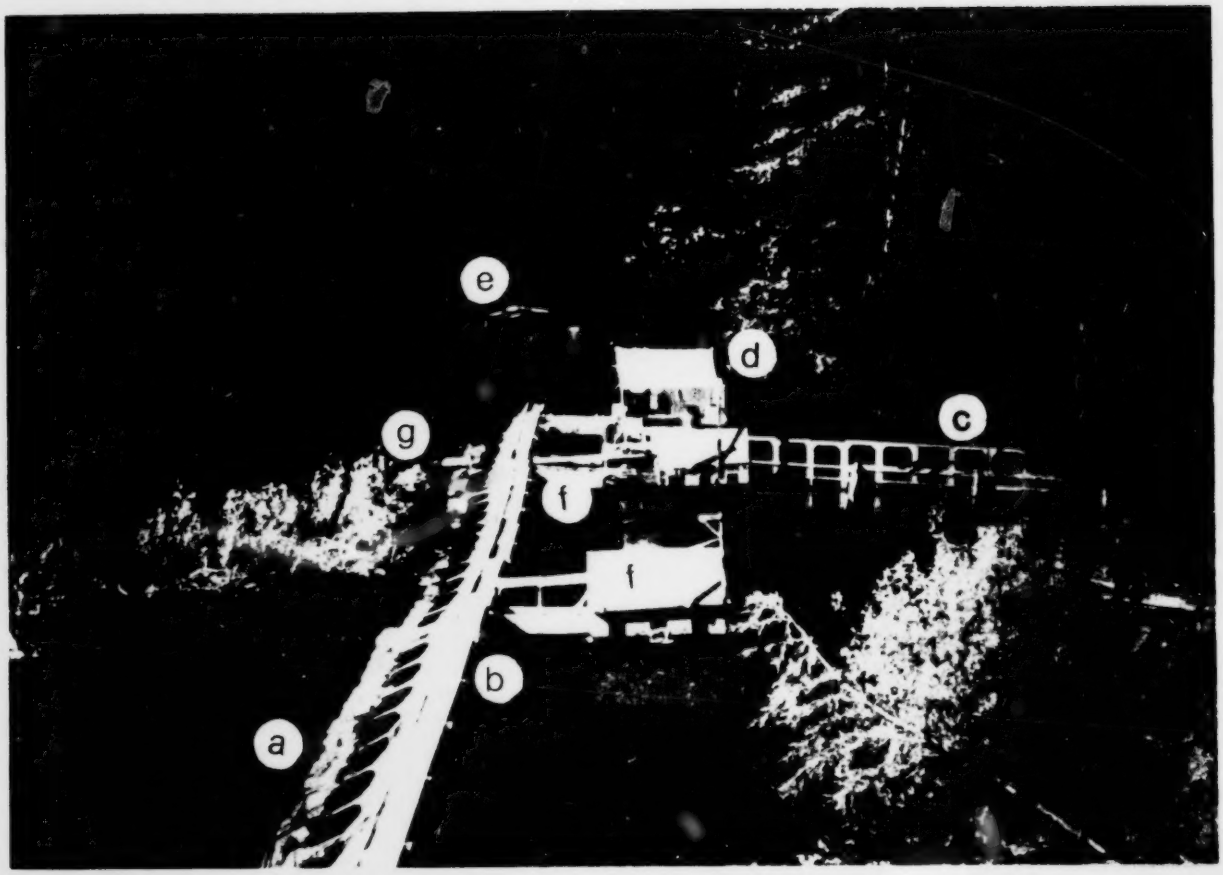

Fig. 2. Hobiton River fence site, 1984. (a) Sandbag and plastic apron seal along upstream fence margin (b) A-frames supporting catwalk (c) Main channel of river bordered by lead wing of fence (d) Sampling platform (e) Shed for electronic counter installation (f) smolt traps (g) outlet bay to electronic counter tunnels.

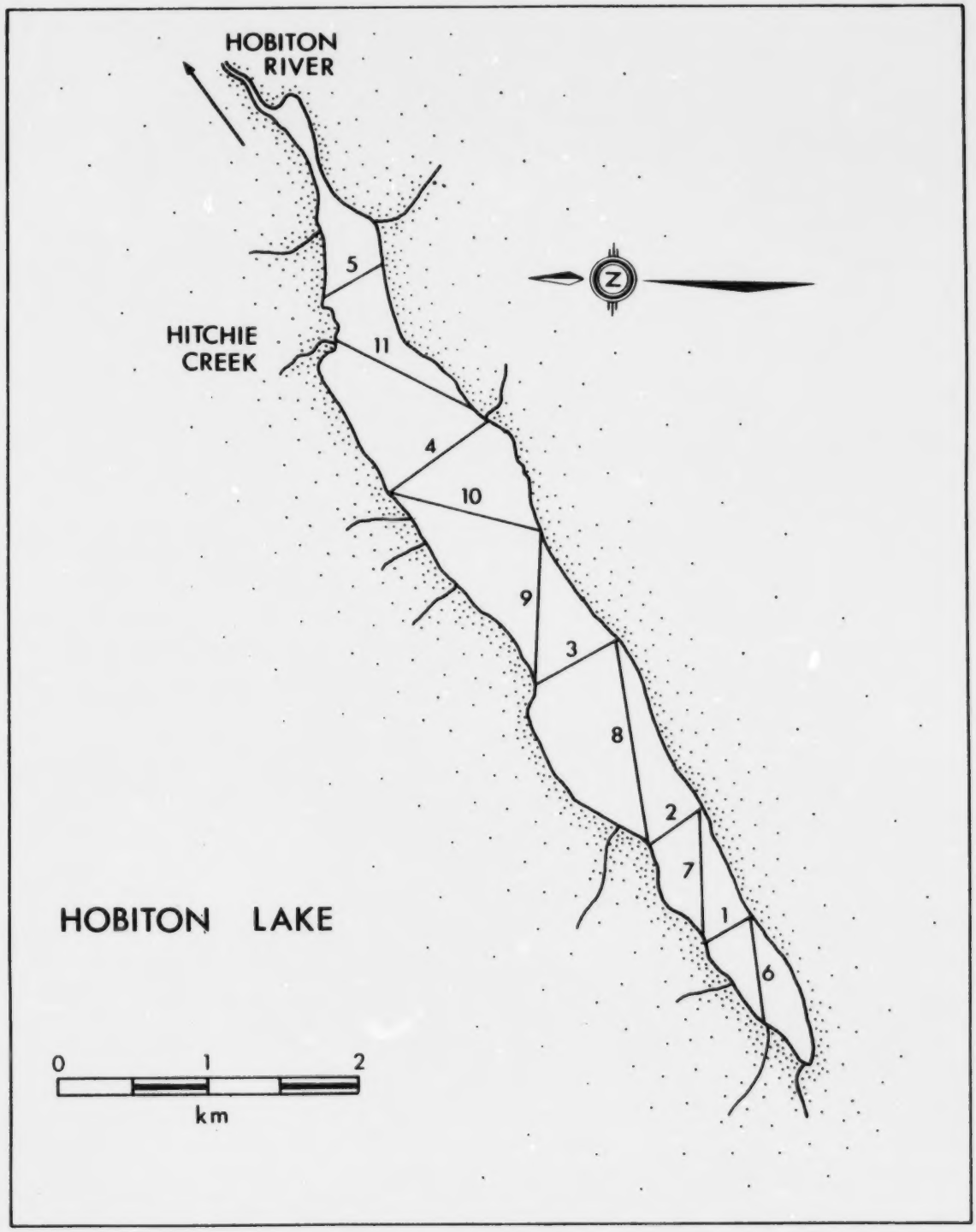

Fig. 3. Location of transects used for hydroacoustic surveys of adult sockeye escapement at Hobiton Lake between 1982 and 1984.

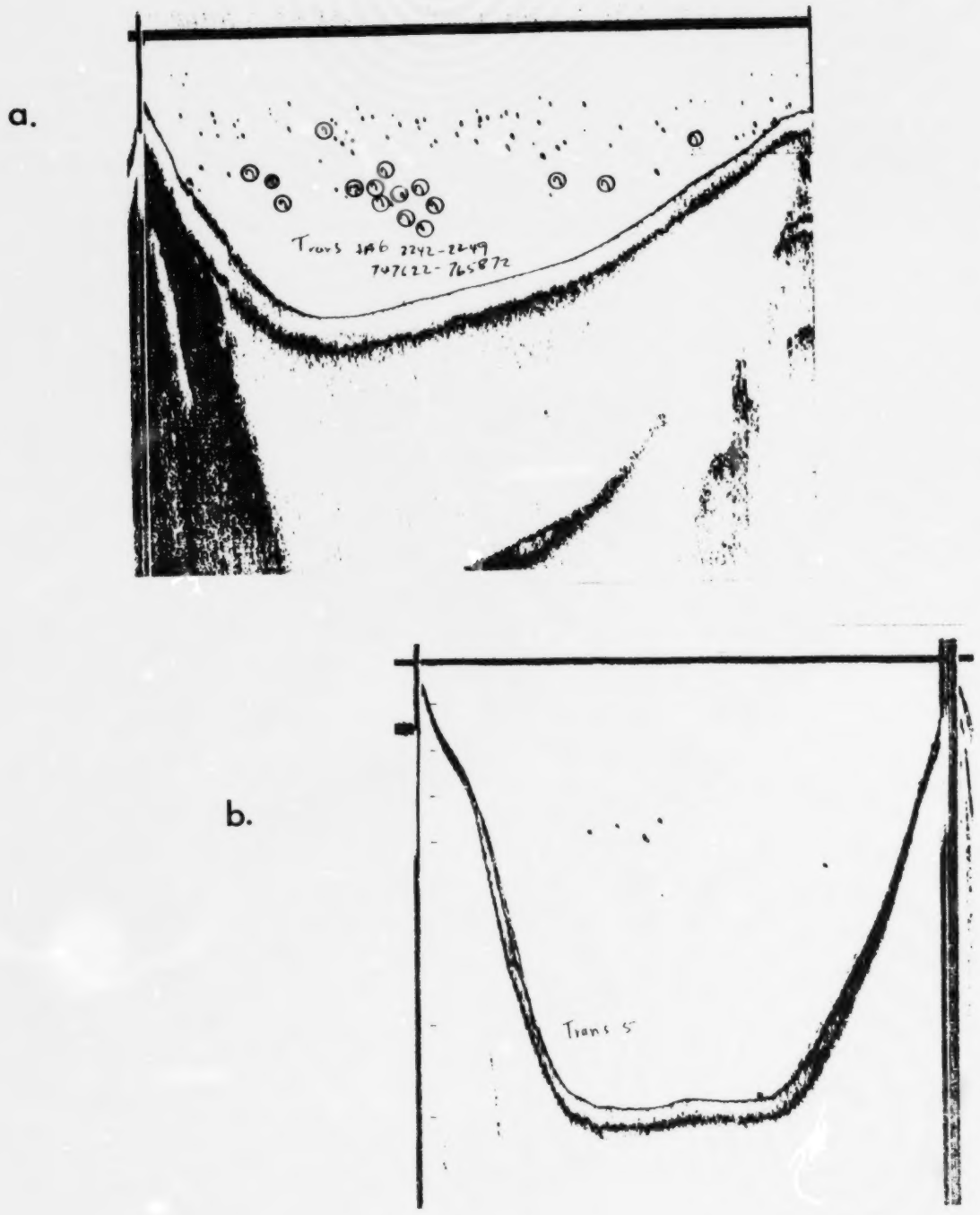

Fig. 4. Ecohgrams from cross-lake transects completed on a singly date with the Simrad sounder
(a) at gain setting 10 with characteristic acoustic targets from both adult and juvenile sockeye identified and
(b) at gain setting 4 in which only acoustic targets from adult sockeye are recorded.

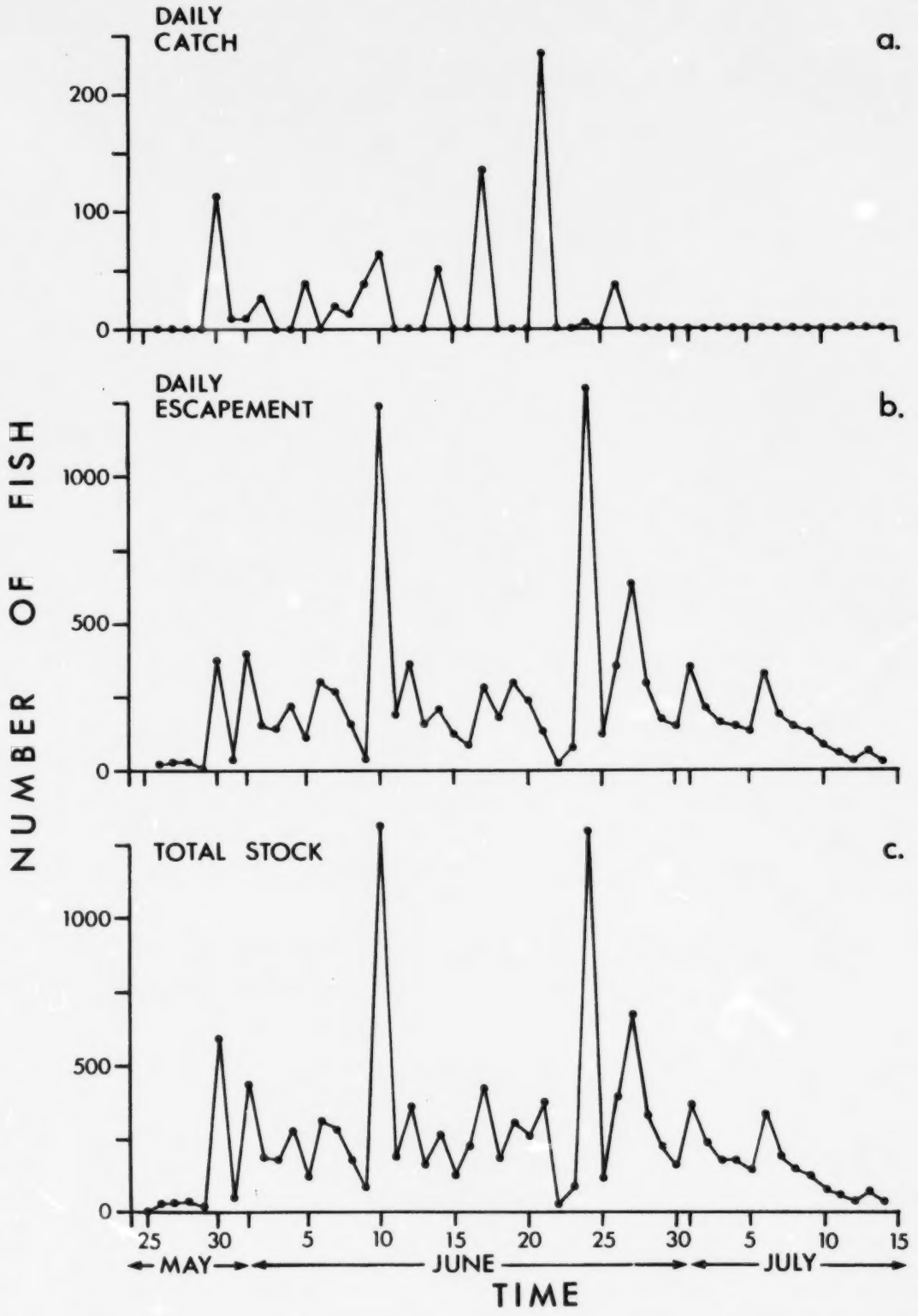

Fig. 5. Daily fluctuations in (a) catch (b) escapement and (c) total stock for Hobiton sockeye, 1984.

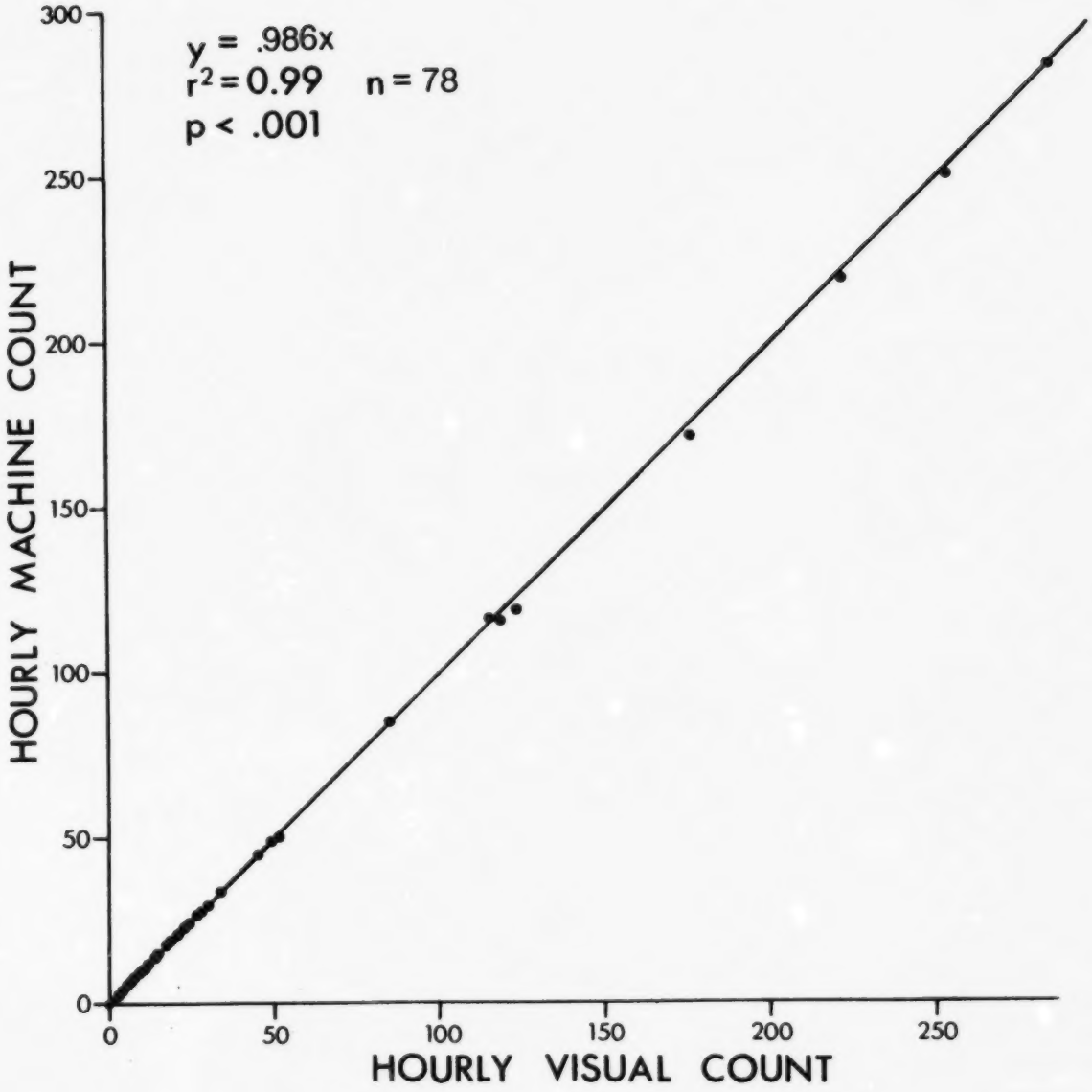

Fig. 6. Relationship between simultaneous visual and electronic counts of adult sockeye passing through counting tunnels at the Hobiton fence.

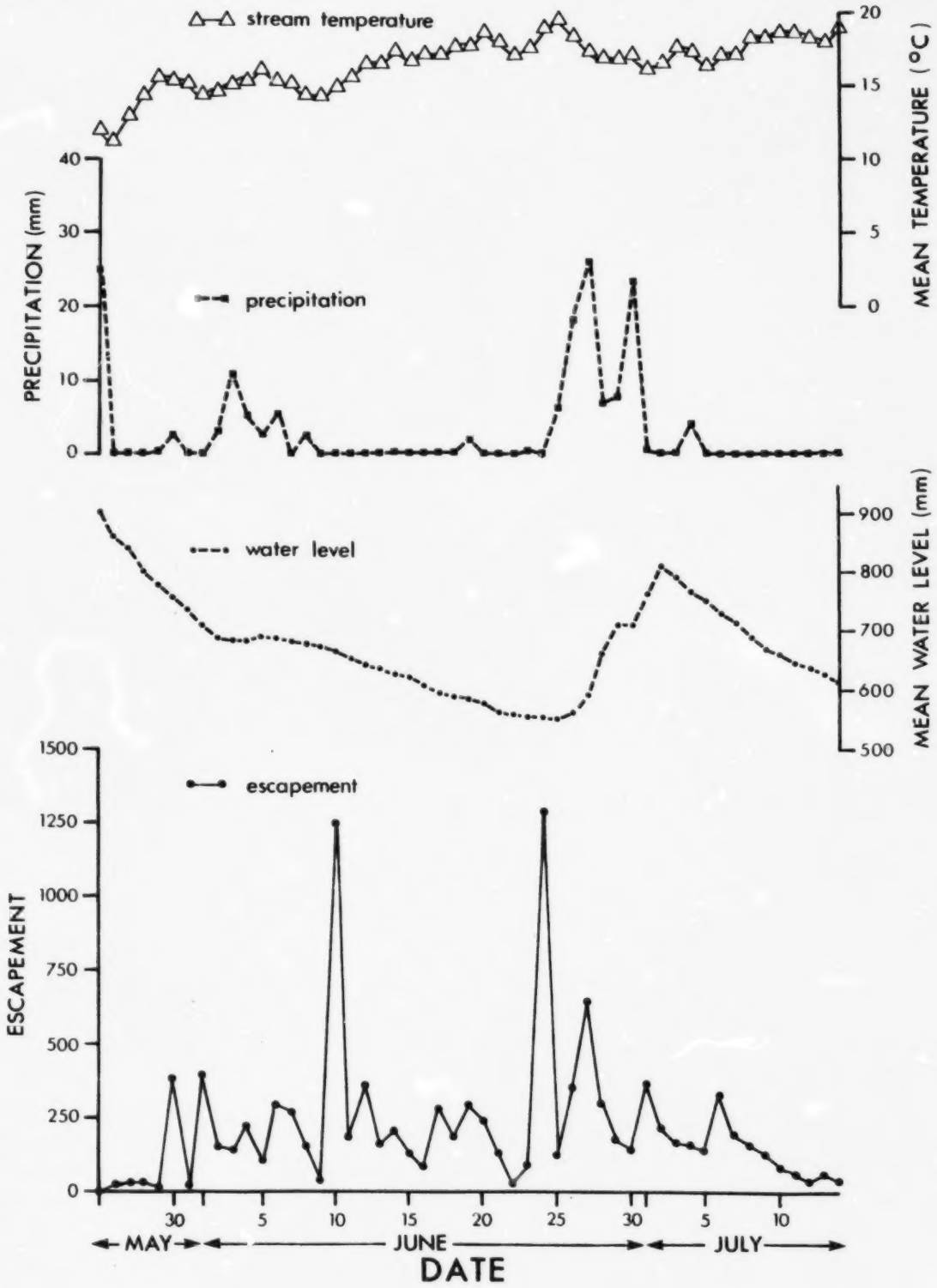

Fig. 7. Daily changes in escapement of sockeye into Hobiton Lake in relation to stream temperature and river water levels at the Hobiton River weir, and daily precipitation at the Nitinat Hatchery.

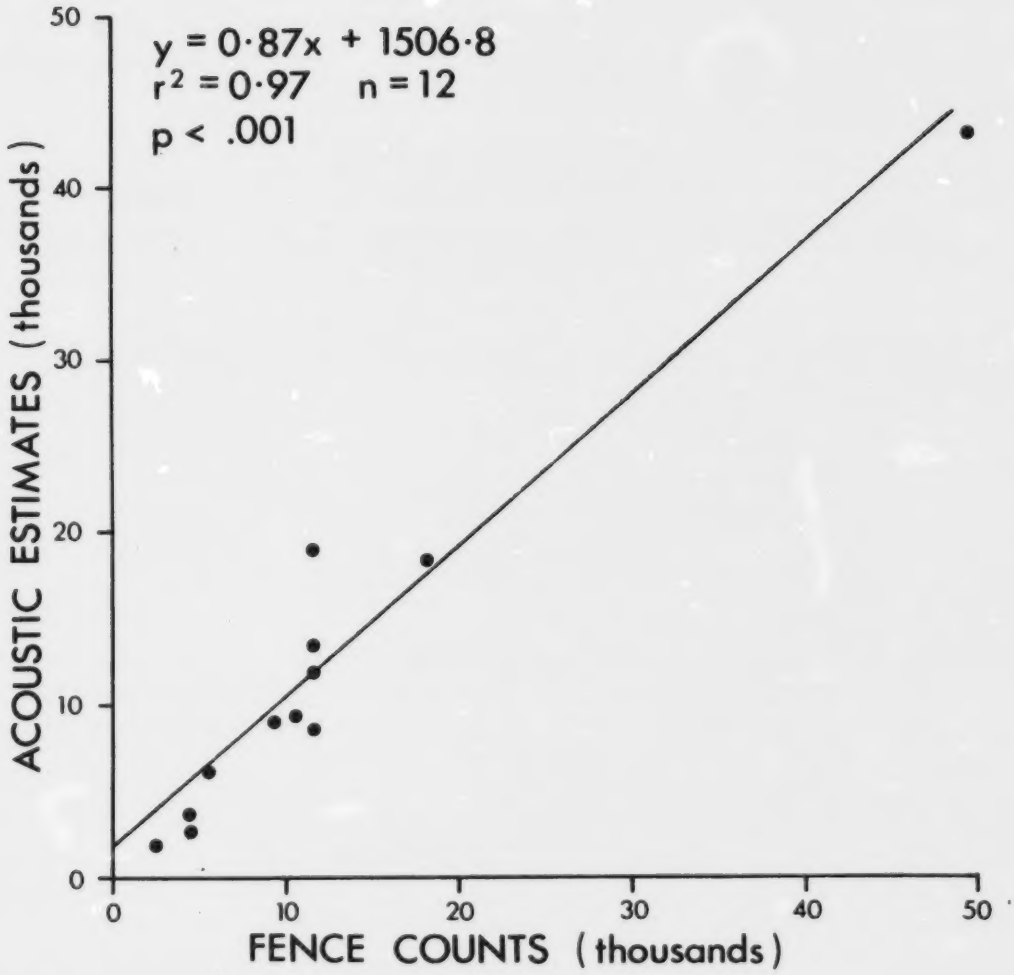

Fig. 8. Relationship between hydroacoustic estimates of escapement in Hobiton Lake and cumulative counts of escapement to a given date at the counting fence.

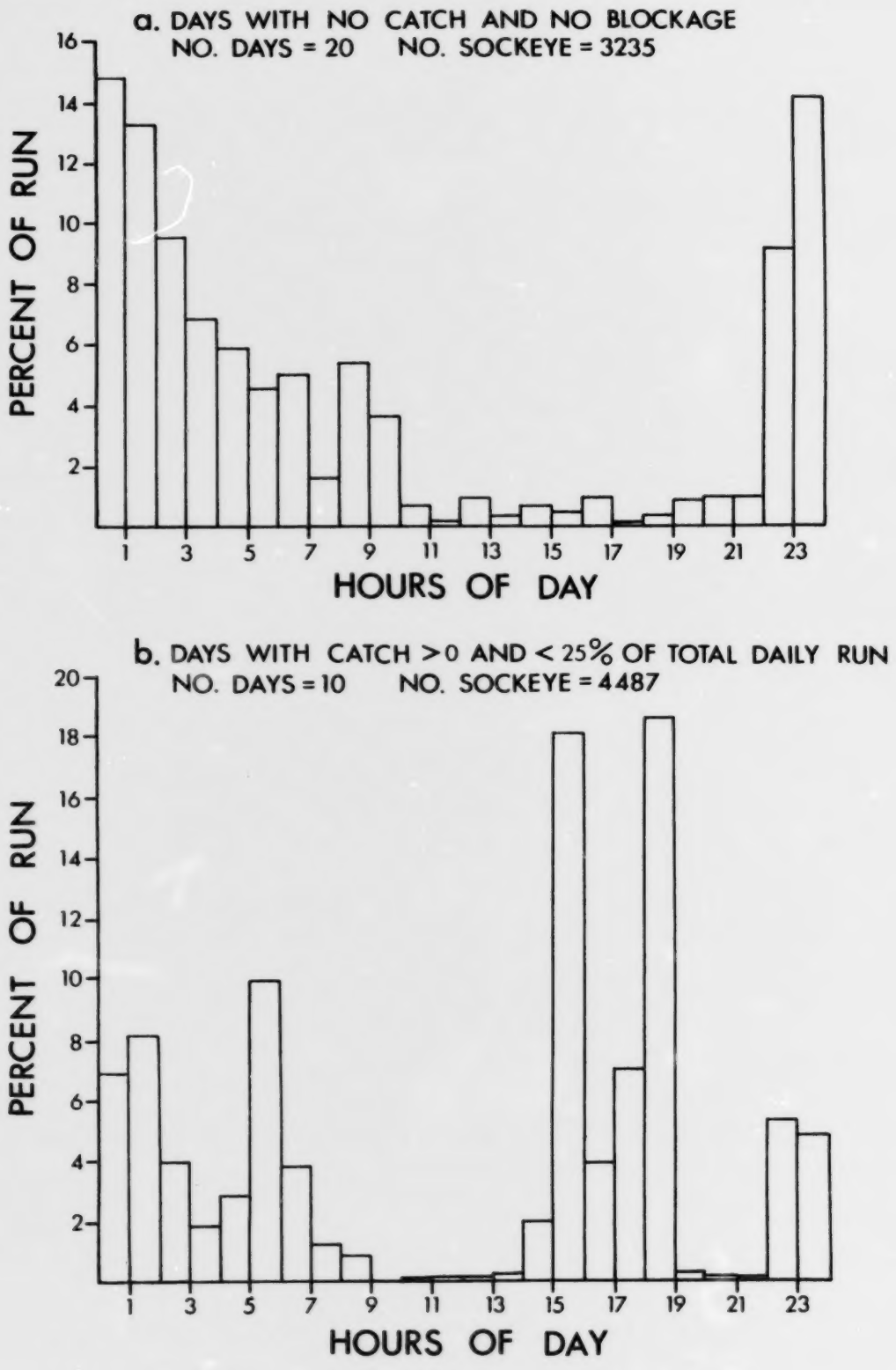
a. DAYS WITH NO CATCH AND NO BLOCKAGE
NO. DAYS = 20 NO. SOCKEYE = 3235
PERCENT OF RUN
HOURS OF DAY
b. DAYS WITH CATCH >0 AND < 25% OF TOTAL DAILY RUN
NO. DAYS = 10 NO. SOCKEYE = 4487
PERCENT OF RUN
HOURS OF DAY

Fig. 9. Diel migration patterns of Hobiton sockeye pooled for selected days when (a) Indian food fish (IFF) catch = 0% of the total run and (b) IFF catch was > 0 and ≤ 25% of the total diel run.

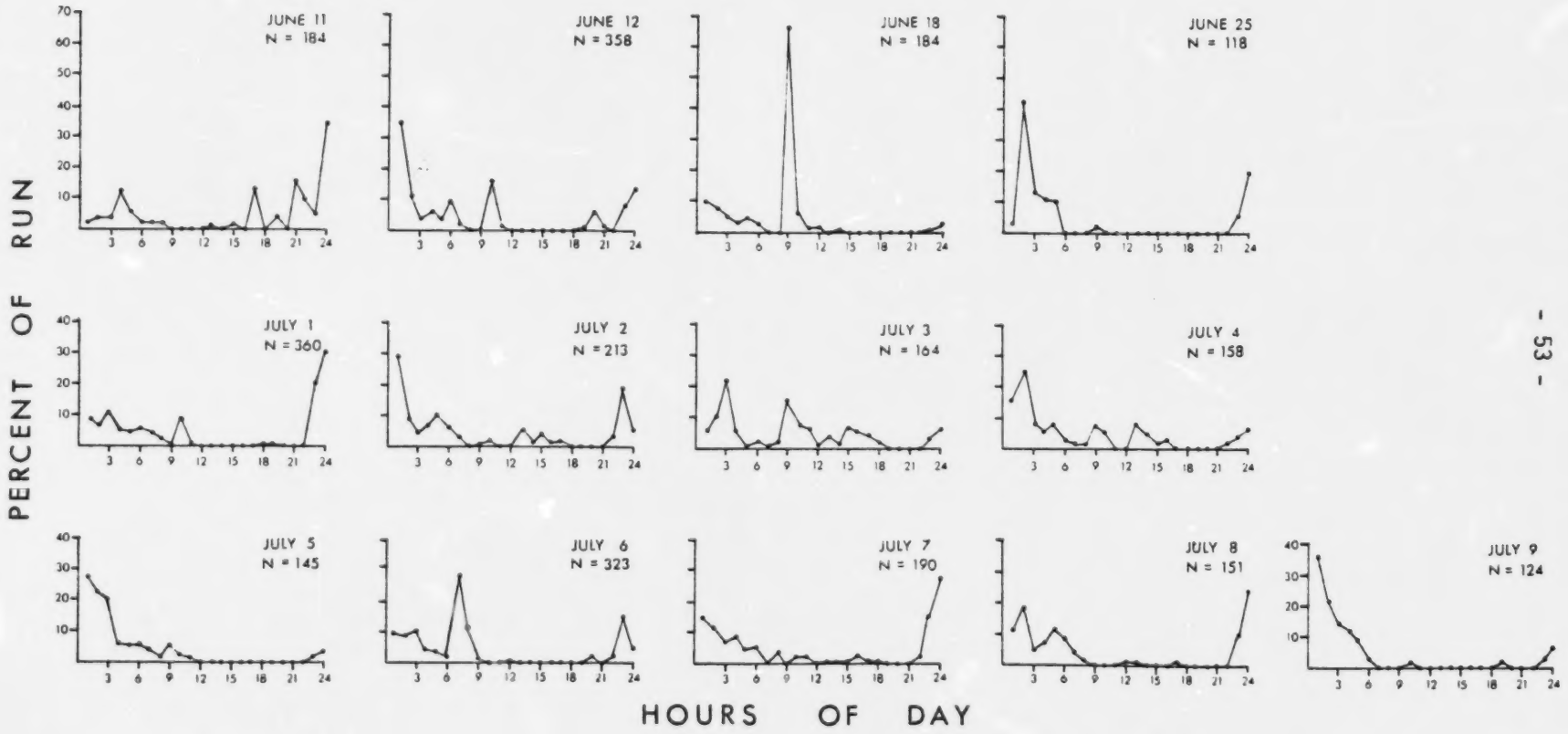

Fig. 10. Diel migration patterns for Hobiton River adult sockeye on selected dates in the absence of any fishing activity.

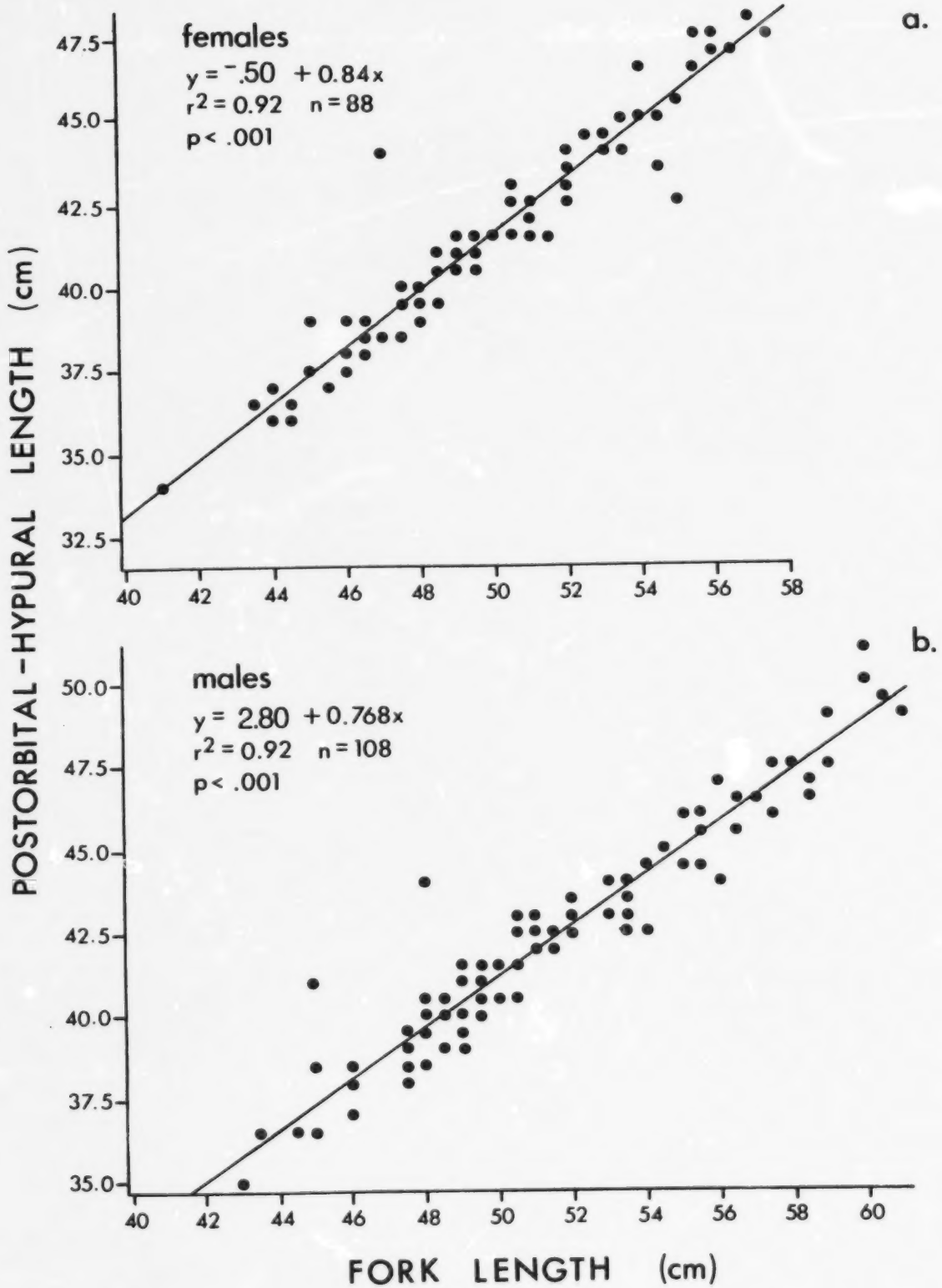

Fig. 11. Relationships between adult sockeye fork length and postorbital-hypural length for Hobiton Lake (a) males and (b) females in 1984.

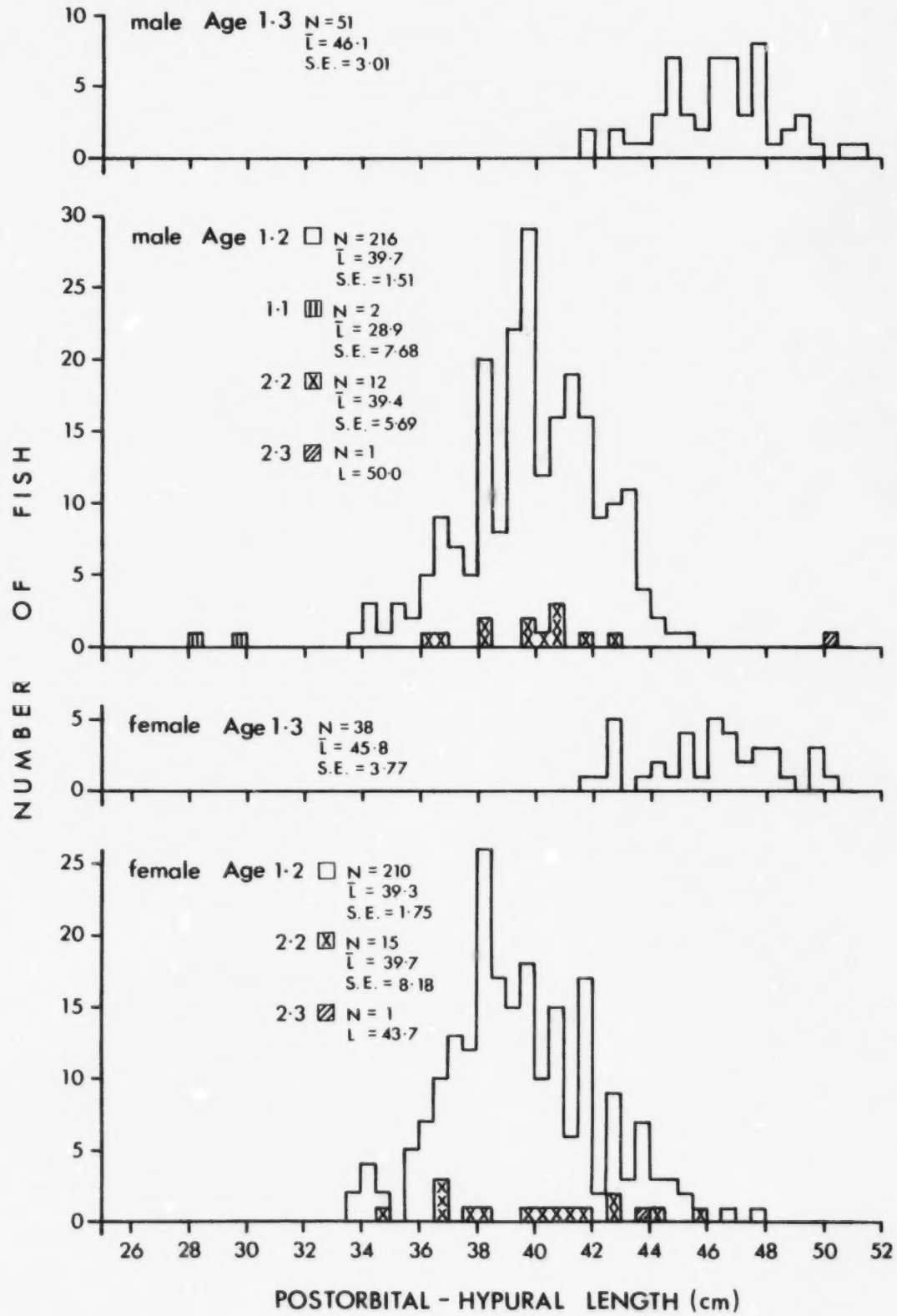

Fig. 12. Length frequency distributions of Hobiton Lake sockeye in 1984 by age and sex.

APPENDICES

Appendix 1. Simultaneous visual and machine counts of adult sockeye, Hobiton River, 26 May - 10 July, 1984.

Appendix 2. Hourly machine counts of adult sockeye migrants at the Hobiton fence in 1984 by year, month and day.

Appendix 3. Adjusted hourly machine counts of adult sockeye migrants at the Hobiton fence in 1984 by year, month and day.

Appendix 4. Percent of diel sockeye migration, by hour at Hobiton Lake in 1984 when (a) no fishing activity occurred and (b) native catch was >0 but $\leq$ 25% of the daily escapement total.

Appendix 5. A summary of river and climatic conditions at Hobiton Lake between April 10 and July 14, 1984.

Appendix 1. Simultaneous visual and machine counts of adult sockeye at Hobiton River, 26 May - 10 July, 1984.

Observation#	Date	Time	Auto Count	Visual Count	Comments
1	2605	0500-0600	23	38	1
2	2605	2030-2130	0	7	1
3	2705	1622-1700	1	1	5
4	2805	0600-0700	27	27	
5	2805	2015-2100	0	0	5
6	2905	0600-0700	4	2	2
7	3005	0430-0500	10	10	5
8	3005	0500-0600	250	254	
9	3005	0600-0700	116	118	
10	3105	0744-0800	5	5	5
11	3105	1303-1400	5	5	5
12	0206	0500-0600	10	10	
13	0206	0600-0700	14	14	
14	0506	0600-0700	23	23	
15	0606	0600-0700	3	3	
16	0706	0600-0700	2	2	
17	0806	0600-0700	0	0	
18	1006	0600-0700	24	24	
19	1006	1600-1700	172	177	
20	1106	1600-1700	20	20	
21	1206	0600-0700	2	2	
22	1206	1424-1500	0	0	5
23	1206	1500-1600	0	0	
24	1206	2000-2100	1	1	
25	1606	2000-2100	0	0	
26	1606	2100-2134	0	0	5
27	1706	0600-0700	4	4	
28	1706	0700-0800	1	1	
29	1706	2000-2100	0	0	
30	1806	0500-0600	3	3	
31	1806	0600-0700	0	0	
32	1806	0800-0900	116	116	
33	1806	2200-2300	1	1	
34	1806	2300-2400	2	2	

Appendix 1 cont'd

Observation#	Date	Time	Auto Count	Visual Count	Comments
35	1906	2200-2300	162	160	3
36	1906	2300-2400	9	12	3
37	2106	0800-0900	0	0	
38	2306	0600-0700	50	51	
39	2306	0700-0800	11	11	
40	2406	0600-0700	1	1	
41	2406	0700-0800	0	0	
42	2506	0407-0500	9	9	5
43	2506	0500-0600	0	0	
44	2506	0600-0700	0	0	
45	2606	0600-0700	0	0	
46	2606	0700-0800	2	2	
47	2606	2200-2300	0	0	
48	2606	2300-2400	22	22	
49	2706	0000-0100	219	224	
50	2706	0100-0200	284	286	
51	0107	0639-0700	1	1	5
52	0107	0700-0800	3	3	
53	0207	0600-0619	0	10	4,5
54	0207	0619-0700	3	2	2,5
55	0207	0700-0800	1	1	
56	0207	2300-2400	9	9	
57	0307	0000-0100	8	8	
58	0307	0700-0800	4	4	
59	0307	0800-0900	26	26	
60	0307	2200-2300	3	3	
61	0307	2300-2331	2	2	5
62	0407	0700-0800	1	1	
63	0407	0800-0900	10	10	
64	0407	0900-1000	7	7	
65	0407	2200-2300	5	5	
66	0407	2300-2400	9	9	
67	0507	0700-0800	1	1	
68	0507	0800-0900	7	7	
69	0507	2300-2400	5	5	
70	0607	0000-0100	30	30	

Appendix 1 cont'd

Observation#	Date	Time	Auto Count	Visual Count	Comments
71	0607	0700-0800	85	85	
72	0607	0800-0900	4	4	
73	0607	2300-2400	15	15	
74	0707	0000-0100	27	27	
75	0707	0700-0800	3	3	
76	0707	0800-0900	0	0	
77	0707	2300-2400	49	49	
78	0807	0000-0100	17	17	
79	0807	0700-0800	1	1	
80	0807	0800-0900	0	0	
81	0807	2200-2300	18	18	
82	0807	2300-2400	34	34	
83	0907	0000-0100	45	45	
84	0907	0700-0800	0	0	
85	0907	0800-0900	0	0	
86	0907	2200-2300	2	2	
87	1007	2200-2300	0	0	

1. Tunnels closed from 0000-0500. Machine count calibration error high for 0500-0600 counts. One tunnel bank not counting. Tunnels blocked unless observers on site. 20:30 - 21:30 visual count only.

2. Suspected observer error.

3. Calibration error may have been the result of the use of Dichromate lights for night counts which seemed to cause abnormal "back and forth" movement of fish within the tunnels.

4. Counter malfunction - dropped tunnels 2 and 4.

5. Count less than an hour.

Appendix 2. Hourly machine counts of adult salmon migrants at the Hobiton Fence 1984 by year, month and day.

YR/MO/DY	0000 0100	0100 0200	0200 0300	0300 0400	0400 0500	0500 0600	0600 0700	0700 0800	0800 0900	0900 1000	1000 1100	1100 1200
	1200 1300	1300 1400	1400 1500	1500 1600	1600 1700	1700 1800	1800 1900	1900 2000	2000 2100	2100 2200	2200 2300	2300 2400
84/05/25	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	0	0	0	0
84/05/26	0	0	0	0	0	23	1	0	0	0	0	0
	0	0	0	-	-	-	-	-	-	-	-	-
84/05/27	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	1	0	0	0	0	0	0	0
84/05/28	0	0	0	0	0	0	27	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
84/05/29	0	0	0	0	0	0	4	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
84/05/30	0	0	0	0	10	250	116	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
84/05/31	0	0	0	0	0	0	0	5	-	-	-	-
	0	5	0	0	0	0	0	0	0	0	8	16
84/06/01	38	24	28	12	77	107	1	9	12	0	0	0
	0	0	0	0	0	0	3	0	2	0	52	28
84/06/02	37	57	19	4	0	10	14	0	0	0	0	0
	0	0	0	0	0	5	2	3	0	0	0	0
84/06/03	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	3	2	66	73
84/06/04	77	39	20	23	31	2	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	4	20
84/06/05	17	19	16	4	3	14	23	2	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	2	3
84/06/06	5	51	56	45	21	15	3	1	4	0	0	0
	0	0	1	1	0	0	0	0	0	0	27	64
84/06/07	78	53	36	7	20	4	2	0	9	0	0	2
	3	1	0	0	0	9	2	0	0	1	10	22

Appendix 2 cont'd

YR/MO/DY	0000 0100	0100 0200	0200 0300	0300 0400	0400 0500	0500 0600	0600 0700	0700 0800	0800 0900	0900 1000	1000 1100	1100 1200
	1200 1300	1300 1400	1400 1500	1500 1600	1600 1700	1700 1800	1800 1900	1900 2000	2000 2100	2100 2200	2200 2300	2300 2400
84/06/08	15	14	7	10	2	1	0	0	0	0	1	0
	0	0	0	0	0	0	0	0	0	0	29	73
84/06/09	11	4	1	2	5	2	0	3	3	1	0	0
	0	0	0	0	0	0	0	1	0	1	0	2
84/06/10	0	3	1	5	5	58	24	39	14	0	0	0
	1	0	94	799	172	3	0	0	0	0	5	7
84/06/11	2	4	4	20	7	1	1	1	0	0	0	0
	1	0	1	0	20	0	6	0	29	17	6	63
84/06/12	116	37	9	15	8	29	2	0	0	48	2	0
	0	0	0	0	0	0	0	21	1	0	24	41
84/06/13	9	9	22	13	32	10	0	0	0	0	0	0
	0	0	0	0	1	6	10	0	35	1	0	4
84/06/14	7	7	4	0	1	2	11	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	129	42
84/06/15	34	13	3	10	9	19	1	1	0	0	0	0
	0	0	0	10	16	2	0	3	0	0	0	0
84/06/16	0	0	0	0	0	0	0	0	0	0	0	13
	14	0	0	0	0	0	0	0	0	2	10	43
84/06/17	78	41	15	5	2	5	4	1	0	0	0	0
	0	0	0	0	0	0	1	0	0	0	71	48
84/06/18	17	13	5	1	6	3	0	0	116	11	3	3
	0	1	0	0	0	0	0	0	0	0	1	2
84/06/19	5	7	19	10	4	35	0	0	0	0	0	0
	0	0	0	0	1	3	1	0	0	35	162	9
84/06/20	45	27	66	36	13	3	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	44
84/06/21	31	23	53	16	3	0	0	4	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
84/06/22	0	0	1	0	0	0	0	6	8	2	0	0
	1	0	0	0	0	0	0	0	0	0	0	0

Appendix 2 cont'd

YR/MO/DY	0000 0100	0100 0200	0200 0300	0300 0400	0400 0500	0500 0600	0600 0700	0700 0800	0800 0900	0900 1000	1000 1100	1100 1200
	1200 1300	1300 1400	1400 1500	1500 1600	1600 1700	1700 1800	1800 1900	1900 2000	2000 2100	2100 2200	2200 2300	2300 2400
84/06/23	0	0	0	0	0	1	50	11	6	0	0	0
	0	0	0	0	0	0	0	0	1	0	2	16
84/06/24	22	52	34	35	2	2	1	0	0	0	0	0
	0	0	0	0	0	294	819	9	0	0	2	1
84/06/25	3	49	15	12	11	0	0	0	1	0	0	0
	0	0	0	0	0	0	0	0	0	0	6	20
84/06/26	109	151	45	13	3	4	0	2	1	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	22
84/06/27	219	285	92	20	2	12	2	1	2	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
84/06/28	51	96	69	41	14	6	2	0	1	0	0	1
	1	0	1	8	0	0	0	0	0	0	0	2
84/06/29	71	42	21	13	5	1	0	0	0	1	0	0
	0	0	0	0	0	0	0	15	0	0	0	0
84/06/30	0	8	56	4	14	28	2	1	2	0	0	0
	0	0	1	2	0	0	0	0	2	0	1	25
84/07/01	27	18	37	17	16	20	10	3	0	28	1	0
	0	0	0	0	0	1	1	0	0	0	71	106
84/07/02	62	18	9	12	22	11	-	1	1	2	0	0
	9	1	5	1	2	0	0	0	0	3	37	9
84/07/03	8	17	34	8	2	3	2	4	26	11	10	1
	4	1	9	6	5	2	0	0	0	0	3	7
84/07/04	24	38	13	8	13	3	1	1	10	7	0	0
	13	6	2	3	0	0	0	0	0	1	5	9
84/07/05	39	32	28	8	7	7	5	1	7	2	1	0
	0	0	0	0	0	0	0	0	0	0	1	5
84/07/06	30	28	33	11	9	6	89	35	4	0	0	1
	0	0	0	0	0	0	0	4	0	6	48	15
84/07/07	27	21	13	16	9	10	0	3	0	2	2	0
	0	1	1	3	1	1	0	0	0	3	27	49

Appendix 2 cont'd

YR/MO/DY	0000 0100	0100 0200	0200 0300	0300 0400	0400 0500	0500 0600	0600 0700	0700 0800	0800 0900	0900 1000	1000 1100	1100 1200
	1200 1300	1300 1400	1400 1500	1500 1600	1600 1700	1700 1800	1800 1900	1900 2000	2000 2100	2100 2200	2200 2300	2300 2400
84/07/08	17	27	7	10	15	13	5	1	0	0	0	1
	1	0	0	0	1	0	0	0	0	0	18	34
84/07/09	45	27	16	13	10	2	0	0	0	1	0	0
	0	0	0	0	0	0	1	0	0	0	2	6
84/07/10	19	15	6	5	14	10	5	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	4
84/07/11	21	12	5	6	9	3	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	1
84/07/12	10	5	6	6	3	1	1	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	3
84/07/13	3	10	9	4	3	6	0	1	0	0	1	0
	0	0	0	0	0	0	0	0	0	0	14	13
84/07/14	3	12	13	1	1	3	0	0	0	0	0	-
	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3. Adjusted hourly machine counts of adult sockeye migrants at the Hobiton Fence in 1984 by year, month and day.

YR/MO/DY	0000 0100	0100 0200	0200 0300	0300 0400	0400 0500	0500 0600	0600 0700	0700 0800	0800 0900	0900 1000	1000 1100	1100 1200
	1200 1300	1300 1400	1400 1500	1500 1600	1600 1700	1700 1800	1800 1900	1900 2000	2000 2100	2100 2200	2200 2300	2300 2400
84/05/25	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	0	0	0	0
84/05/26	0	0	0	0	0	23	1	0	0	0	0	0
	0	0	0	-	-	-	-	-	0	0	0	0
84/05/27	0	0	0	0	0	12	14	0	0	0	0	0
	0	0	0	-	1	0	0	0	0	0	0	0
84/05/28	0	0	0	0	0	0	27	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
84/05/29	0	0	0	0	0	0	4	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
84/05/30	0	0	0	0	10	254	118	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
84/05/31	0	0	0	0	0	0	0	5	6	0	0	0
	0	5	0	0	0	0	0	0	0	0	8	16
84/06/01	39	24	28	12	78	109	1	9	12	0	0	0
	0	0	0	0	0	0	3	0	2	0	53	28
84/06/02	38	58	19	4	0	10	14	0	0	0	0	0
	0	0	0	0	0	5	2	3	0	0	0	0
84/06/03	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	3	2	67	74
84/06/04	78	40	20	23	31	2	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	4	20
84/06/05	17	19	16	4	3	14	23	2	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	2	3
84/06/06	5	52	57	46	21	15	3	1	4	0	0	0
	0	0	1	1	0	0	0	0	0	0	27	65
84/06/07	79	54	37	7	20	4	2	0	9	0	0	2
	3	1	0	0	0	9	2	0	0	1	10	22

Appendix 3 cont'd

YR/MO/DY	0000 0100 0100 0200	0100 0200 0200 0300	0200 0300 0300 0400	0300 0400 0400 0500	0400 0500 0500 0600	0500 0600 0600 0700	0600 0700 0700 0800	0700 0800 0800 0900	0800 0900 0900 1000	0900 1000 1000 1100	1000 1100 1100 1200	1100 1200 1200 1300
84/06/08	15	14	7	10	2	1	0	0	0	0	1	0
	0	0	0	0	0	0	0	0	0	0	29	74
84/06/09	11	4	1	2	5	2	0	3	3	1	0	0
	0	0	0	0	0	0	0	1	0	1	0	2
84/06/10	0	3	1	5	5	59	24	40	14	0	0	0
	1	0	95	810	174	3	0	0	0	0	5	7
84/06/11	2	4	4	20	7	1	1	1	0	0	0	0
	1	0	1	0	20	0	6	0	29	17	6	64
84/06/12	118	38	9	15	8	29	2	0	0	49	2	0
	0	0	0	0	0	0	0	21	1	0	24	42
84/06/13	9	9	22	13	33	10	0	0	0	0	0	0
	0	0	0	0	1	6	10	0	36	1	0	4
84/06/14	7	7	4	0	1	2	11	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	131	43
84/06/15	35	13	3	10	9	19	1	1	0	0	0	0
	0	0	0	10	16	2	0	3	0	0	0	0
84/06/16	0	0	0	0	0	0	0	0	0	0	0	13
	14	0	0	0	0	0	0	0	0	2	10	44
84/06/17	79	42	15	5	2	5	4	1	0	0	0	0
	0	0	0	0	0	0	1	0	0	0	72	49
84/06/18	17	13	5	1	6	3	0	0	118	11	3	3
	0	1	0	0	0	0	0	0	0	0	1	2
84/06/19	5	7	19	10	4	36	0	0	0	0	0	0
	0	0	0	0	1	3	1	0	0	36	164	9
84/06/20	46	27	67	37	13	3	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	45
84/06/21	31	23	54	16	3	0	0	4	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
84/06/22	0	0	1	0	0	0	0	6	8	2	0	0
	1	0	0	0	0	0	0	0	0	0	0	0

Appendix 3 cont'd

YR/MO/DY	0000 0100	0100 0200	0200 0300	0300 0400	0400 0500	0500 0600	0600 0700	0700 0800	0800 0900	0900 1000	1000 1100	1100 1200
	1200 1300	1300 1400	1400 1500	1500 1600	1600 1700	1700 1800	1800 1900	1900 2000	2000 2100	2100 2200	2200 2300	2300 2400
84/06/23	0	0	0	0	0	1	51	11	6	0	0	0
	0	0	0	0	0	0	0	0	1	0	2	16
84/06/24	22	53	35	36	2	2	1	0	0	0	0	0
	0	0	0	0	0	298	831	9	0	0	2	1
84/06/25	3	50	15	12	11	0	0	0	1	0	0	0
	0	0	0	0	0	0	0	0	0	0	6	20
84/06/26	111	153	46	13	3	4	0	2	1	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	22
84/06/27	222	289	93	20	2	12	2	1	2	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
84/06/28	52	97	70	42	14	6	2	0	1	0	0	1
	1	0	1	8	0	0	0	0	0	0	0	2
84/06/29	72	43	21	13	5	1	0	0	0	1	0	0
	0	0	0	0	0	0	0	15	0	0	0	0
84/06/30	0	8	57	4	14	28	2	1	2	0	0	0
	0	0	1	2	0	0	0	0	2	0	1	25
84/07/01	27	18	38	17	16	20	10	3	0	28	1	0
	0	0	0	0	0	1	1	0	0	0	72	108
84/07/02	63	18	9	12	22	11	6	1	1	2	0	0
	9	1	5	1	2	0	0	0	0	3	38	9
84/07/03	8	17	35	8	2	3	2	4	26	11	10	1
	4	1	9	6	5	2	0	0	0	0	3	7
84/07/04	24	39	13	8	13	3	1	1	10	7	0	0
	13	6	2	3	0	0	0	0	0	1	5	9
84/07/05	40	33	28	8	7	7	5	1	7	2	1	0
	0	0	0	0	0	0	0	0	0	0	1	5
84/07/06	30	28	34	11	9	6	90	36	4	0	0	1
	0	0	0	0	0	0	0	4	0	6	49	15

Appendix 3 cont'd

YR/MO/DY	0000 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200	1200 1300 1400 1500 1600 1700 1800 1900 2000 2100 2200 2300 1300 1400 1500 1600 1700 1800 1900 2000 2100 2200 2300 2400
84/07/07	27 21 13 16 9 10 0 3 0 2 2 0	0 1 1 3 1 1 0 0 0 3 27 50
84/07/08	17 27 7 10 15 13 5 1 0 0 0 1	1 0 0 0 1 0 0 0 0 0 18 35
84/07/09	46 27 16 13 10 2 0 0 0 1 0 0	0 0 0 0 0 0 1 0 0 0 2 6
84/07/10	19 15 6 5 14 10 5 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 4
84/07/11	21 12 5 6 9 3 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 1
84/07/12	10 5 6 6 3 1 1 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 3
84/07/13	3 10 9 4 3 6 0 1 0 0 1 0	0 0 0 0 0 0 0 0 0 0 14 13
84/07/14	3 12 13 1 1 3 0 0 0 0 0 -	- - - - - - - - - - - -

Appendix 4. Percent of diel sockeye migration, by hour at Hobiton Lake in 1984 when (a) no fishing activity occurred and (b) native catch was >0 by ≤25% of the daily escapement total.

Hour	0%	>0&<=25%
1	14.82	6.91
2	13.18	8.15
3	9.52	3.93
4	6.77	1.95
5	5.77	2.71
6	4.46	9.89
7	5.03	3.82
8	1.62	1.24
9	5.28	0.95
10	3.50	0.00
11	0.62	0.02
12	0.18	0.04
13	0.87	0.09
14	0.31	0.14
15	0.59	2.12
16	0.43	18.05
17	0.90	3.89
18	0.12	7.02
19	0.25	18.66
20	0.78	0.27
21	0.94	0.04
22	0.93	0.02
23	9.05	5.31
24	14.08	4.77
# DAYS	20	10
# FISH	3235	4487

Appendix 5. A summary of river and climatic conditions of Hobiton Lake between April 10 and July 14, 1984.

PHYSICAL PARAMETERS DURING MONITORING

DATES	WATER LEVEL (M)			WATER TEMPERATURE (CELSIUS)			PRECIPITATION (MM)			WEATHER
YR/MO/DY	AM	PM	MEAN	AM	PM	MEAN	AM	PM	TOTAL	COMMENTS
84/04/10	.950	.980	.960	7.0	7.0	7.0	5.4	39.0	44.4	100% OCAST
84/04/11	1.080	1.140	1.110	7.0	-	7.0	16.8	12.8	29.6	100% OCAST-LIGHT RAIN
84/04/12	1.190	1.210	1.200	7.0	7.0	7.0	20.8	2.8	23.6	100% OCAST-HEAVY RAIN
84/03/13	1.160	1.110	1.135	7.0	7.0	7.0	0.2	18.0	18.2	100% OCAST-RAIN
84/04/14	1.060	1.050	1.055	7.0	7.0	7.0	0.0	1.8	1.8	CLEAR W SCAT CLOUD
84/04/15	1.000	.980	.990	8.0	8.0	8.0	8.8	4.2	13.0	OCAST W RAIN
84/04/16	1.050	-	1.050	8.0	-	8.0	1.4	0.8	2.2	OCAST W CLEAR BREAKS
84/04/17	.910	.890	.900	8.5	9.5	9.0	0.2	7.2	7.4	CLEAR W SCAT CLOUD
84/04/18	.870	.870	.870	9.0	9.5	9.3	7.4	2.0	9.4	OCAST W RAIN, SUNNY BREAKS
84/04/19	.860	.850	.855	9.0	9.5	9.3	0.9	0.4	1.3	OCAST W RAIN
84/04/20	.830	.820	.825	8.5	9.5	9.0	1.0	19.8	20.8	100% OCAST W SOME RAIN
84/04/21	.830	.820	.825	9.5	9.5	9.5	5.0	9.8	14.8	50% OCAST
84/04/22	.850	.920	.885	9.0	8.0	8.5	31.0	6.4	37.4	100% OCAST-HEAVY RAIN
84/04/23	1.000	.970	.985	8.5	9.0	8.75	0.2	0.2	0.4	CLEAR W SCAT CLOUD
84/04/24	.950	.920	.985	9.0	9.5	9.3	0.0	0.0	0.0	CLEAR W SCAT CLOUD
84/04/25	.890	.870	.880	9.5	10.0	9.7	0.0	0.0	0.0	CLEAR
84/04/26	-	.830	.830	-	11.0	11.0	0.0	0.0	0.0	CLEAR
84/04/27	.810	.800	.805	11.0	12.0	11.5	0.0	0.0	0.0	CLEAR
84/04/28	.770	.765	.767	11.0	12.0	11.5	0.0	0.0	0.0	CLEAR
84/04/29	.740	.745	.743	11.0	11.0	11.0	0.0	10.8	10.8	100% OCAST
84/04/30	.745	.780	.763	10.0	10.5	10.3	11.4	8.6	20.0	100% OCAST-HEAVY RAIN
84/05/01	.830	.850	.840	10.0	10.5	10.3	3.2	16.4	19.6	100% OCAST
84/05/02	.860	.860	.860	10.0	10.0	10.0	1.2	6.0	7.2	OCAST W SOME CLEARING
84/05/03	.850	.840	.845	10.0	-	10.0	0.8	0.0	0.8	CLEAR>OCAST W RAIN
84/05/04	.830	.800	.815	10.5	10.5	10.5	0.6	2.0	2.6	100% OCAST
84/05/05	.800	.790	.795	10.5	11.0	10.75	3.2	4.0	7.2	100% OCAST-LIGHT RAIN
84/05/06	.780	.750	.765	10.5	11.0	10.75	0.2	0.0	0.2	CLEAR W SCAT CLOUD
84/05/07	.750	.740	.745	11.0	11.0	11.0	0.0 T	18.4	18.4	100% OCAST-RAIN
84/05/08	.765	.780	.773	10.5	11.0	10.75	5.2	22.0	27.2	100% OCAST-HEAVY RAIN

Appendix 5 cont'd

DATES	WATER LEVEL (M)			WATER TEMPERATURE (CELSIUS)			PRECIPITATION (MM)			WEATHER
YR/MO/DY	AM	PM	MEAN	AM	PM	MEAN	AM	PM	TOTAL	COMMENTS
84/05/09	.820	.860	.840	10.5	11.0	10.75	11.2	11.8	23.0	100% OCAST-RAIN
84/05/10	.885	.910	.898	10.0	11.0	10.5	0.6	16.6	17.2	100% OCAST-RAIN
84/05/11	.920	-	.920	10.5	-	10.5	4.2	5.4	9.6	100% OCAST-RAIN
84/05/12	.970	-	.970	10.5	-	10.5	0.0	4.4	4.4	PART OCAST, SUNNY PERIODS
84/05/13	.940	.920	.930	11.5	11.0	11.25	3.6	16.8	20.5	100% OCAST-LIGHT RAIN
84/05/14	.910	.910	.910	11.0	12.0	11.5	11.0	5.6	16.6	100% OCAST-LIGHT RAIN
84/05/15	.900	.900	.900	12.0	12.0	12.0	1.8	0.4	2.2	SUNNY W SCAT CLOUD
84/05/16	.870	.860	.865	12.0	12.0	12.0	0.6	0.0 T	0.6	100% OCAST>CLEARING
84/05/17	.840	.820	.830	12.0	12.5	12.25	0.0T	8.4	8.4	100% OCAST>CLEARING
84/05/18	.810	.810	.810	12.0	12.0	12.0	8.0	41.0	49.0	100% OCAST-RAIN
84/05/19	.850	1.170	1.010	12.0	11.5	11.75	23.0	6.8	29.8	100% OCAST-HEAVY RAIN
84/05/20	1.150	1.120	1.135	11.0	11.0	11.0	2.0	4.4	6.4	100% OCAST-SHOWERS
84/05/21	1.080	1.030	1.055	11.0	12.0	11.5	1.0	10.8	11.8	100% OCAST>CLEARING
84/05/22	1.000	.970	.985	13.0	12.0	12.5	2.6	19.4	22.0	100% OCAST-RAIN
84/05/23	.960	.960	.960	12.0	12.0	12.0	3.8	0.8	4.6	OCAST W CLEAR BREAKS
84/05/24	.930	.925	.928	12.0	13.0*	12.5	0.2	0.0 T	0.2	CLEAR/SUNNY>SCAT CLOUD
84/05/25	.900	.900	.900	12.0	12.0	12.0	5.8	19.2	25.0	100% OCAST>RAIN
84/05/26	.860	.855	.858	10.5	12.0	11.25	0.0	0.0	0.0	CLEAR>OCAST W SOME CLEARING
84/05/27	.840	.835	.838	12.0	13.5	12.75	0.0	0.0	0.0	OCAST>CLEARING
84/05/28	.810	.790	.800	13.5	15.0	14.25	0.0	0.0	0.0	PARTIALLY OCAST
84/05/29	.780	.770	.775	15.0	16.0	15.5	0.0	0.4	0.4	HIGH FOG>CLEARING/75% OCAST
84/05/30	.760	.750	.755	15.5	15.0	15.25	2.0	0.8	2.8	100% OCAST>CLEARING
84/05/31	.740	.720	.730	14.0	16.0	15.0	0.0	0.0	0.0	CLEAR/SUNNY
84/06/01	.710	.700	.705	14.5	14.0	14.25	0.0	0.0	0.0	HIGH FOG>SOME CLEARING
84/06/02	.690	.680	.685	14.0	15.0	14.5	0.0	3.0	3.0	CLEAR>SCAT CLOUD
84/06/03	.680	.685	.683	15.0	15.0	15.0	2.4	8.8	11.2	100% OCAST-RAIN
84/06/04	.680	.680	.680	14.5	16.0	15.25	0.2	4.6	4.8	LIGHT RAIN>50% OCAST(PM)
84/06/05	.690	.690	.690	16.0	16.0	16.0	1.2	1.4	2.6	100% OCAST>RAIN
84/06/06	.685	.690	.688	15.0	15.5	15.25	5.2	0.2	5.4	HIGH FOG>CLEAR SKIES
84/06/07	.680	.680	.680	15.0	15.0	15.0	0.0 T	0.0	0.0	HIGH FOG>75% OCAST

Appendix 5 cont'd

DATES	WATER LEVEL (M)			WATER TEMPERATURE (CELSIUS)			PRECIPITATION (MM)			WEATHER
YR/MO/DY	AM	PM	MEAN	AM	PM	MEAN	AM	PM	TOTAL	COMMENTS
84/06/08	.675	.675	.675	14.5	14.0	14.25	0.2	2.4	2.6	100% OCAST
84/06/09	.675	.670	.673	14.0	14.5	14.25	0.0 T	0.0	0.0	OCAST>CLEAR W SCAT CLOUD
84/06/10	.660	-	.660	14.0	15.5	14.75	0.0	0.0	0.0	100% OCAST
84/06/11	.660	.650	.655	15.0	16.0	15.5	0.0	0.0	0.0	100% OCAST(FOG)>CLEAR
84/06/12	.645	.640	.643	16.0	17.0	16.5	0.0	0.0	0.0	100% OCAST(FOG)>CLEAR
84/06/13	.630	-	.630	16.5	-	16.5	0.0	0.0	0.0	FOG>CLEAR SKIES
84/06/14	.630	.620	.625	17.0	17.5	17.25	0.0	0.0	0.0	FOG>50% OCAST
84/06/15	.620	-	.620	16.5	-	16.5	0.0	0.0	0.0	100% OCAST-DRIZZLE
84/06/16	.610	.600	.605	17.0	17.0	17.0	0.0	0.0	0.0	FOG>CLEAR SKIES (PM)
84/06/17	.600	.590	.595	16.0	18.0	17.0	0.0	0.0	0.0	FOG>CLEAR SKIES (PM)
84/06/18	.590	.580	.585	17.0**	18.0	17.5	0.0	0.0	0.0	CLEAR SKIES>FOG
84/06/19	.580	.580	.580	17.0	18.0	17.5	1.0	1.0	2.0	100% OCAST-SHOWERS
84/06/20	-	.575	.575	-	18.5	18.5	0.0	0.0 T	0.0	100% OCAST
84/06/21	.570	.565	.568	18.0	17.5	17.75	0.0	0.0	0.0	100% OCAST-SHOWERS
84/06/22	.565	.560	.563	17.0	17.0	17.0	0.0	0.0	0.0	SHOWERS>CLEAR W SCAT CLOUD
84/06/23	.560	.555	.558	17.0	18.0	17.5	0.0	0.6	0.6	CLEAR>100% OCAST W LIGHT RAIN
84/06/24	.560	.550	.555	18.0	19.5	18.75	0.0	0.0	0.0	100% OCAST>CLEAR SKIES
84/06/28	.645	.690	.668	16.5	17.0	16.75	5.8	0.8	6.6	100% OCAST-LIGHT RAIN
84/06/29	.710	.710	.710	16.5	17.0	16.75	4.0	3.8	7.8	RAIN>CLEAR W SCAT CLOUD
84/06/30	.710	-	.710	17.0	-	17.0	0.2	23.2	23.4	100% OCAST-RAIN
84/07/01	.740	.790	.765	16.0	16.0	16.0	0.4	0.0	0.4	100% OCAST-LIGHT RAIN
84/07/02	.810	.810	.810	16.0	17.0	16.5	0.0	0.0	0.0	100% OCAST
84/07/03	.800	.790	.795	17.0	18.0	17.5	0.0	0.0	0.0	100% OCAST
84/07/04	.780	.760	.770	17.5	17.0	17.25	1.2	2.8	4.0	100% OCAST-LIGHT RAIN
84/07/05	.760	.750	.755	16.5	16.0	16.25	0.0	0.0	0.0	90% OCAST>CLEAR W 1/2 MOON
84/07/06	.740	.725	.733	17.0	17.0	17.0	0.0	0.0	0.0	75% OCAST>CLEAR
84/07/07	.720	.710	.715	17.0	17.5	17.25	0.0	0.0	0.0	CLEAR SKIES
84/07/08	.700	.685	.693	18.0	18.5	18.25	0.0	0.0	0.0	100% OCAST (FOG)>CLEAR
84/07/09	.680	.670	.675	18.0	18.5	18.25	0.0	0.0	0.0	100% OCAST (FOG)>50% OCAST
84/07/10	.665	.650	.658	18.0	19.0	18.5	0.0	0.0	0.0	100% OCAST>CLEAR SKIES

Appendix 5 cont'd

DATES	WATER LEVEL (M)			WATER TEMPERATURE (CELSIUS)			PRECIPITATION (MM)			WEATHER
YR/MO/DY	AM	PM	MEAN	AM	PM	MEAN	AM	PM	TOTAL	COMMENTS
84/07/11	.645	.640	.643	18.5	18.5	18.5	0.0	0.0	0.0	100% OCAST (FOG)
84/07/12	.635	-	.635	18.0	18.5	18.25	0.0	0.0	0.0	100% OCAST (FOG)
84/07/13	.625	-	.625	18.0	-	18.0	0.0	0.0	0.0	CLEAR W SCAT CLOUD
84/07/14	.610	-	.610	19.0	-	19.0	0.0	0.0	0.0	CLEAR SKIES

*HAND THERMOMETER READ 13 DEGREES CELSIUS: THERMOGRAPH READING 15 DEGREES CELSIUS @ 2200 HRS.
**HAND THERMOMETER READING: THERMOGRAPH RECORDED 15 DEGREES CELSIUS
T=trace